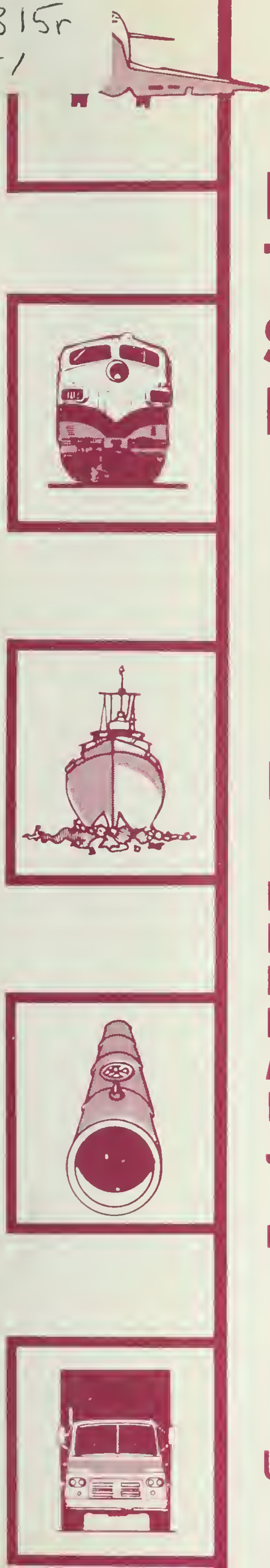

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

ILLINOIS CENTRAL GULF RAILROAD COMPANY FREIGHT TRAIN DERAILMENT HAZARDOUS MATERIAL RELEASE AND EVACUATION MULDRAUGH, KENTUCKY JULY 26, 1980

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16. Abstract

About 7:58 a.m., on July 26, 1980, 4 locomotive units and 17 cars, including 7 placarded tank cars containing hazardous materials, of Illinois Central Gulf Railroad Company freight train No. 64 were derailed while moving at a calculated speed of about 35 mph around a 6° curve in Muldraugh, Kentucky. Two tank cars of vinyl chloride were punctured and their contents burned. Flames impinged two other tank cars of vinyl chloride, causing one to vent toxic fumes, but neither car ruptured. About 6,500 persons were evacuated from Muldraugh and the U.S. Army installation at Fort Knox. Four train crewmembers were injured during the derailment, and property damage was estimated at $1,348,394.

The National Transportation Safety Board determines that the probable cause of the accident was the tipping of the outside rail and widening of track gage in the 6° curve because of the combined effects of defective crossties, excessively worn rail, irregular alignment and gage, and the lateral forces produced by the train's speed. Inadequate maintenance and inspection practices of the Illinois Central Gulf Railroad allowed these conditions to remain uncorrected. Contributing to the accident was the inadequate Federal Track Safety Standards which failed to provide for a track structure commensurate with the permitted train speeds.

17. Key Words derailment; freight train; tipped rail; track standards; worn rail; track alignment; track gage; hazardous materials; evacuation; tank cars.

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: February 3, 1981

ILLINOIS CENTRAL GULF RAILROAD COMPANY FREIGHT TRAIN DERAILMENT HAZARDOUS MATERIAL RELEASE AND EVACUATION MULDRAUGH, KENTUCKY JULY 26, 1980

SYNOPSIS

About 7:58 a.m., on July 26, 1980, 4 locomotive units and 17 cars, including 7 placarded tank cars containing hazardous materials, of Illinois Central Gulf Railroad Company freight train No. 64 were derailed while moving at a calculated speed of about 35 mph around a 6° curve in Muldraugh, Kentucky. Two tank cars of vinyl chloride were punctured and their contents burned. Flames impinged two other tank cars of vinyl chloride, causing one to vent toxic fumes, but neither car ruptured. About 6,500 persons were evacuated from Muldraugh and the U.S. Army installation at Fort Knox. Four train crewmembers were injured during the derailment, and property damage was estimated at $1,348,394.

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INVESTIGATION

The Accident

Illinois Central Gulf (ICG) northbound freight train No. 64, consisting of 4 locomotive units and 38 cars, departed Central City, Kentucky, about 2:20 a.m. on July 26, 1980, for Louisville, Kentucky. Transfer reports did not specify any defects and a roll-by inspection of the train equipment at Central City revealed no defects.

As the train traveled between Central City and Cecilia, Kentucky, it passed two hot-box detectors which indicated no defects. The fireman, a qualified locomotive engineer, was operating the train; the engineer and head brakeman were seated opposite him on the left side of the control compartment in the lead locomotive unit.

After traveling 18.7 miles from Cecilia, the train started down a 1.1 percent grade in Muldraugh, Kentucky, which is surrounded by the U. S. Army's Fort Knox. To maintain a constant descending speed and to prevent train slack from running in, the fireman made a 12-pound brakepipe reduction and kept the throttle in the No. 5 position. The train left the descending grade and entered a 101-foot-long straight section of track approaching a 6° curve to the right, 216 feet north of signal No. 27.2. About 7:58 a.m. as the locomotive entered the curve, at an indicated speed of 26 to 30 mph according to the fireman, the crewmembers on the locomotive heard a "popping" sound from the front of the lead unit and felt the lead unit "fishtail" as the rear of the lead unit derailed. The fireman immediately placed the train brakes in emergency and held onto the control stand to keep from being thrown about the cab. The other two crewmembers braced themselves at the left side of the locomotive. The three trailing locomotive units overturned to the left pulling the coupled lead unit over. All of the locomotive units remained coupled. The lead end of the locomotive came to rest about 645 feet north of the point of derailment.

The following 17 cars were derailed. (See figure 1.) Seven were tank cars containing hazardous materials. Six of the tank cars carried vinyl chloride and one contained chlorine. Both vinyl chloride and chlorine produce toxic fumes when released to the atmosphere. Two of the tank cars of vinyl chloride were breached. The pressurized compressed gas escaped and formed a gas cloud around the derailed equipment.

The engineer got out of the lead unit via the right-side window opening. He saw a white cloud forming about 6 inches above the ground near the rear locomotive unit. Knowing that hazardous materials were being carried in the seven tank cars, the first being six cars behind the locomotive consist, the engineer quickly assisted the fireman and brakeman through the same window exit.

While standing beside the lead unit, the crewmembers heard what they identified as electrical arcing coming from the battery area of the rear unit. They ran from the wreckage area as the gas cloud ignited. Although not burned, the crewmembers felt a heat wave and a subsequent concussion. They went to a highway that paralleled the track and advised a local police officer there of the derailment and of the hazardous contents of the tank cars, and recommended that the area be evacuated immediately.

After the train stopped, the crewmembers in the caboose had attempted to call the locomotive crewmembers by radio. Because of the violent stop, the crewmembers in the caboose assumed that the train had derailed. Unable to establish communication with the other crewmembers, the flagman and conductor left the caboose. The conductor went to check the track behind the train and the flagman went ahead to check the cars in the train. The conductor saw the gas cloud shortly after he left the caboose, and he advised military personnel at Fort Knox of the derailment. The flagman who was walking from the caboose toward the derailed equipment felt the heat of the burning gas cloud and radioed the train dispatcher and requested emergency aid. He then went to the highway and was escorted to safety by military personnel.

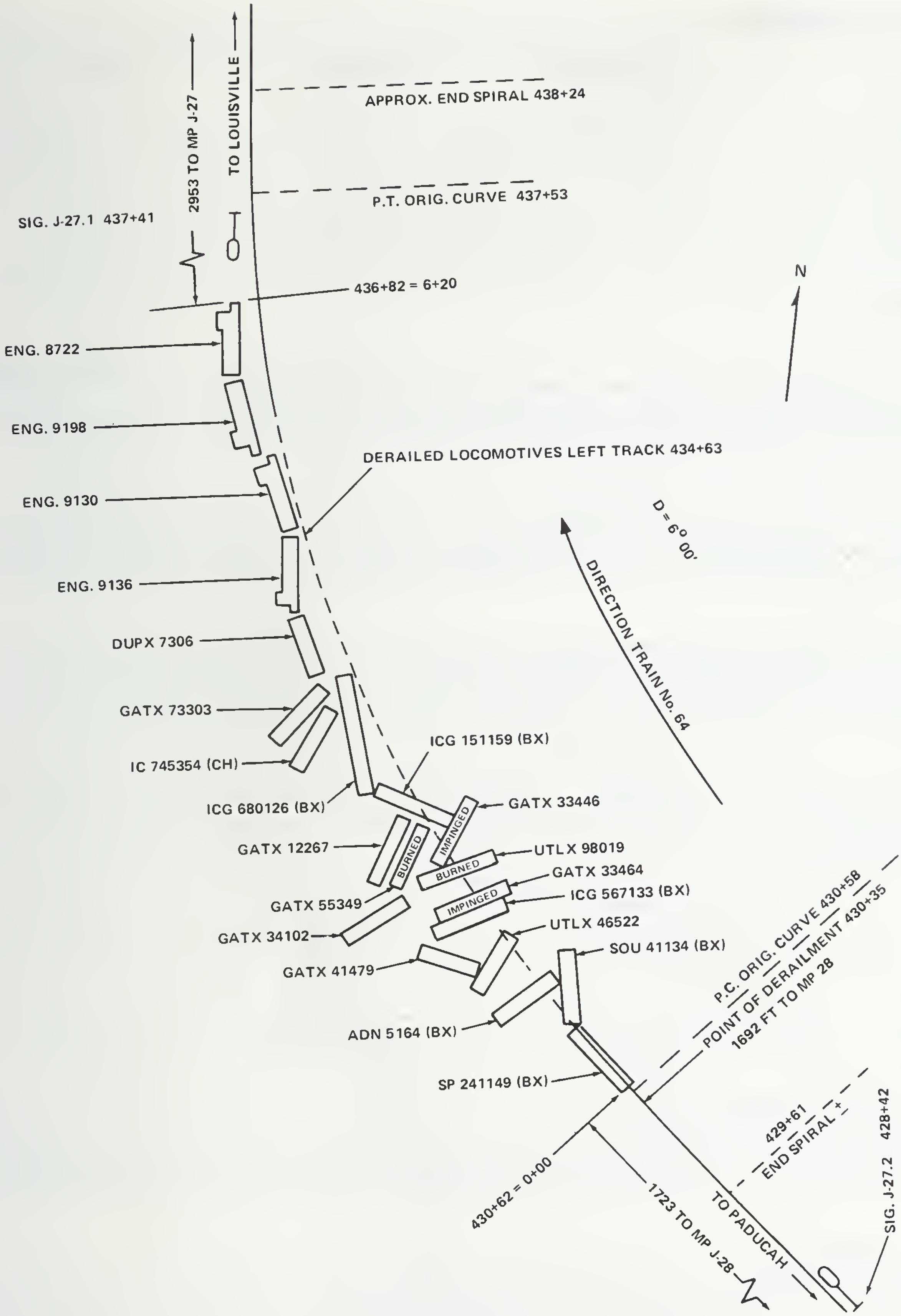


Figure 1.—Plan View of Accident

Injuries to Persons

Injuries	Crewmembers	Passengers	Others	Total
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	4	0	0	4
None	1	0	0	1
Total	5	0	0	5

Damage

The tank car loaded with chlorine was not breached. Two tank cars loaded with vinyl chloride which were punctured were destroyed. One of the other four tank cars that was not punctured lost about 30 percent of its vinyl chloride lading through the safety valve because of overpressure resulting from the heat of the fire.

Of the other 10 derailed cars, which did not carry hazardous materials, 3 sustained light damage, 2 were moderately damaged, 3 were heavily damaged, and 2 were destroyed.

The running gear and car bodies of the first three locomotive units were damaged by the derailment. The fourth unit was destroyed by the fire from the burning vinyl chloride and the spilled fuel oil from the ruptured locomotive fuel tank.

The derailment destroyed or damaged about 645 feet of track. Broken rails and joint bars were found on both sides of the track. The estimated cost of the damage is listed below:

Locomotive equipment	$ 860,000
Car equipment	275,500
Track and signals	11,200
Lading	93,254
Removal of Wreckage	108,440
Total	$1,348,394

Crewmember Information

All of the crewmembers were qualified according to ICG operating rules. (See appendix B.)

Train Information

Train No. 64, consisting of 28 loaded freight cars, 9 empty freight cars, and a caboose, was 2,528 feet long and had 2,841 trailing tons. The locomotive consisted of four diesel-electric, four-axle units manufactured by the Electro-Motive Division of General Motors.

The lead unit was a model GP-11 and the three other units were model GP-9's. The lead unit was equipped with No. 26-L-type airbrakes, speed indicator,

wheel slip-slide indicator, and an operative radio. The locomotive was not equipped with speed-recording or event-recording equipment.

Immediately behind the locomotive were two empty tank cars, an empty covered hopper, an empty boxcar, and an empty refrigerator car. The 6th through the 11th cars were tank cars containing vinyl chloride. Five of the tank cars had been provided with insulation, head shields, and top-and-bottom shelf couplers that met U. S. Department of Transportation (DOT) specification 112J 340W. One tank car was outfitted to DOT specification 105 A 300W. The 12th car, outfitted to DOT specification 105 A 500W, was loaded with chlorine. All of the tank cars were placarded properly.

Track Information

The track was constructed of 39-foot-long, 115-pound rails connected by 6-hole, 36-inch joint bars. The east rail was laid in 1951 and the west rail in 1977. The rails were placed on 7 3/4-inch by 13-inch, double-shoulder tieplates on an average of 23 hardwood crossties per 39-foot rail length. The track was ballasted with slag and crushed limestone to an average depth of 18 inches. Each rail was secured to the crossties with an average of one spike on the gage side, one spike on the field side, and one plate-holding spike.

The track where the derailment occurred was an 863-foot-long, 6° curve to the right. Spirals were provided at each end. The curve had a 2 1/2-inch superelevation. Approaching this curve from the south, the track was straight for 101 feet. Northbound trains moved on a descending grade of about 1.1 percent approaching the straight track and on a level grade through the curve.

The track was supposed to be maintained to meet the Federal Railroad Administration's (FRA) track safety standards for Class 3 track. (See appendix C.) An FRA geometry car was last operated over the track on December 14, 1979. The survey (see appendix D) found that at the midpoint of the 6° curve, the track gage at a joint was 57.6 inches, which is 1.1 inches wider than standard gage of 56.5 inches. In the next curve, at milepost 27.9, the gage at a joint was 57.8 inches. According to the ICG, the excess gage locations were repaired to meet the standards for Class 3 track, which allow a maximum gage of 57.75 inches. However, there is no record of the repair. The survey also found that the curvature deviated from the designed 6° between 5°30' to 7°, that the superelevation of the curve deviated from the planned 2 1/2 inches up to 3 3/4 inches, and that the profile of the track ranged from 1/2 inch to 1 inch high and low through the curve. The curvature, superelevation, and profile deviations were within the tolerances established by the standards for Class 3 track.

During routine ICG track inspections between June 6, 1980, and July 21, 1980, 15 track defects were recorded between mileposts 16 and 32. The track supervisor reported that the defects were repaired. Among the defects were a number of stripped joints and buckled tracks. As a result of the buckled track, caused by daytime heat, ICG General Order No. 116 was issued on July 18, 1980, limiting the maximum speed of all trains to 30 mph between mileposts 5 and 125 from 10:01 a.m. until 7:01 p.m. Class 3 track permits a maximum of 40 mph for freight trains on straight track and 36 mph through a 6° curve with a 2 1/2-inch superelevation.

A 42-mile section of track that included the accident site was checked twice a week by an ICG track inspector on a motor car moving at speeds of 15 to 20 mph. On July 22, 1980, an FRA track safety inspector and an ICG track supervisor made a visual inspection of the accident curve, and they did not report any defects. However, at mileposts 20.7 and 28.5, the FRA inspector found crosstie defects on each side of the area where the derailment later occurred. There were no other exceptions noted at that location. The FRA inspector cautioned the ICG track supervisor that the rail was flaking metal on the high side of the curve each time a train traversed the track, causing wear and curve-worn rail. He told the ICG inspector that, because of the curve-worn rail, the track gage should be carefully checked. An ICG track inspector inspected the track again on July 24, 1980, and found no reportable defects.

A postaccident inspection revealed that the gage side of the head of the outside rail of the 6° curve was reduced between 28 to 44 percent of its surface. (See appendix E.) The ICG inspector who made the July 24, 1980, inspection said he noticed flange marks on the top of joint bars at milepost 27.5. He said he attributed the flange marks to railhead wear and curve-worn rail on the high side of the curve which would permit the flanges of the wheels to contact the joint bars. He did not note these conditions on the inspection report.

The ICG track supervisor said that he inspected the curve again on July 25, 1980, and took no exceptions to the curve. However, he had scheduled a maintenance-of-way gang to resurface the curve beginning on July 28, 1980. The gang was scheduled to spike crossties left unspiked previously and to replace defective crossties. The ICG had replaced crossties through this area in December 1979 and because of ICG maintenance techniques, about 1 in 10 of the new crossties was left unspiked. The curve-worn rail was scheduled to be replaced later. Since the accident, the ICG has replaced about 600 defective crossties per mile in the 42-mile section. There are about 3,000 crossties per mile in this area.

The track in the accident area was last ultrasonically tested for internal rail defects on November 9, 1979. There were no defects noted in the immediate area of the accident.

Method of Operation

Trains are operated over the Louisville District of the Kentucky Division by an automatic block signal system. The train dispatcher, who is located in Chicago, Illinois, has direct radio communication with trains moving through the accident area. An average of 45 trains per week are operated over the single main track. The trains carry an estimated 7 million gross tons of freight annually.

Efficiency checks were made on trains operating over the Louisville District. In the 6 months prior to the derailment about 150 efficiency checks were reported, including 9 radar speed checks of train No. 64's operation, with no exceptions noted.

Timetable special instructions and several slow orders had reduced the original maximum authorized track speed of 50 mph to as low as 10 mph in some areas. However, on the day of the accident, ICG General Order No. 116 had

reduced the speed of all Louisville District trains to a maximum of 30 mph. This made the minimum running-time between Cecilia and Muldraugh 1 hour 21 minutes.

Meteorological Information

At the time of derailment, it was daylight, the weather was clear, the wind was calm, and the temperature was about 72° F as reported by the Army Weather Service Station at Fort Knox's Godman Field located about 1.8 miles from the derailment site.

Medical and Pathological Information

Of the four injured crewmembers, only the rear brakeman was immediately hospitalized. He had been exposed to the vaporized vinyl chloride for a short time, and he was treated for inhalation of toxic fumes. The engineer, fireman, and head brakeman received emergency treatment. The fireman entered a hospital for observation several days after the occurrence. Although the conductor escaped injury, he did not work for several days because of a nervous condition that reportedly resulted from the accident.

Because of previous experience with accidents involving hazardous chemicals and on the advice of emergency response officials, the wreck-clearing workers waited until most of the gases and smoke had dissipated before attempting major cleanup operations. No injuries were reported by those involved in these activities.

Survival Aspects

Shortly after the derailment, crewmembers informed the Muldraugh Police and Fort Knox military personnel of the leaking and burning hazardous chemicals. The properties of the materials involved and the potential for explosion caused authorities to immediately order the evacuation of about 6,500 persons. About 4,000 of the evacuees were military personnel from Fort Knox.

At about 8:25 a.m., the Kentucky Division of Disaster and Emergency Services (DES) was called in by local authorities to implement an emergency response plan which had been previously established by the State of Kentucky. This plan was immediately put into effect, thereby alerting all State and local emergency services. In addition, the ICG had notified appropriate Federal agencies and shippers about the accident. (see Appendix F). A temporary command post with the DES in charge was established about 3/4 mile from the site and was later moved to an operations building on the Fort Knox base.

In addition to the immediate evacuation of the affected area, three highways (U.S. 31W, U.S. 60, and S.R. 1638) near the derailment site were closed to prevent highway traffic from moving into the hazardous zone. The air space to a 10,000-foot ceiling and for a 3-mile radius surrounding the derailment was closed to all air traffic.

Personnel from the U.S. Environmental Protection Agency (EPA) and representatives from a vinyl chloride shipper tested air samples at the accident site. No traces of vinyl chloride were found in locations away from the immediate vicinity of the derailment. As the hazard subsided, the evacuation area during the

following day was reduced from 2 to 1 1/4 miles. The burning tank cars were intentionally detonated by explosive experts 4 days following the derailment, the fires were extinguished, and the remainder of the evacuees were permitted to return to their homes. Expeditious and efficient emergency actions resulted in no postderailment injuries.

The United States Army provided assistance throughout the emergency. It helped with the evacuation by furnishing personnel, equipment, security, helicopters, and a command post location.

Other Information

Postaccident Inspection of Train Equipment.--A test of the speed indicator installed on the lead locomotive unit revealed that the indicator read 21 mph at an actual speed of 25 mph, 26 mph at 31.4 mph, and 34 mph at 39.3 mph. The engineer and the conductor of train No. 64 said that the speed indicator was checked for accuracy between measured mileposts 118 and 119 in accordance with existing instructions, but because of the slow order in the vicinity, they did not detect the inaccuracies. There were no other measured mileposts before the accident site. Recorded train times by the dispatcher and operators indicated that train No. 64 had operated between Cecilia and Muldraugh in 1 hour 6 minutes.

Inspection of the locomotive wheels disclosed rail abrasions on the outside of the rims.

Even though many of the coupler shanks of the tank cars had broken or the cars had become uncoupled during the derailment sequence, all but two remained coupled during the initial run-in until the cars started jackknifing, breaking the couplers. The two tank car breaches found were both in the sides of the tanks. The 7th car was punctured as the result of a broken rail piercing the jacket and tearing the side of the tank. The mechanism causing the puncture of the 10th car could not be determined, but the car was punctured in the side. There were no head punctures.

After the accident, an inspection of the 7th car disclosed a tear about 2-1/2 inches long and 1/2-inch wide at the center of the tank on the right side about two-thirds of the way down the side from the dome. An inspection of the 10th car disclosed a hole about 1 3/4 inches by 1 1/2 inches about 60 inches from the middle of the tank towards the A-end at the bottom. Fire burned at the punctures on these cars until the cars were detonated.

A large burned area was noted on the 8th car. The burn area was located where the car was directly fire-impinged for more than 72 hours. About 30 percent of the contents of the car was vented through the safety valve. Although the 11th car was fire-impinged over a period of time, no loss of its chemical contents occurred.

Postaccident Inspection of Track.--Track measurements of the undisturbed track for a distance of 859.5 feet south and 232.5 feet north of the derailment site disclosed many deviations from the designated curvature, superelevation, and gage. (See appendix G.) The alignment of a curve located about 400 feet south of the point of derailment varied from $5^{\circ}7'30''$ to $5^{\circ}52'30''$ for the designed 5° curve. The

superelevation of the 5° curve varied from 2 inches to 2 1/2 inches. Because of the derailment damage, only one measurement--a superelevation of 2 1/2 inches--could be made in the 6° curve. Track gage varied from 56.5 to 57.5 inches. However, all of these deviations in track geometry were within the tolerances allowed by the standards for Class 3 track. Broken rails and angle bars found at the accident site were determined to have been broken in the derailment.

Postderailment inspection disclosed defects in crossties, tie plates, and spiking in the approach to and beyond the point of derailment. (See figures 2, 3, 4, and 5.) A defective crosstie, marked by the ICG with a yellow dot prior to the December 14, 1979, FRA geometry car inspection, was found in the middle location at a supported insulated joint on the east rail about 216 feet south of the point of derailment. (See figure 2.) The ICG joint was supported by three crossties. The track safety standards (49 CFR 213.109(d)) require a minimum of one nondefective crosstie at each joint of Class 3 track, and a nondefective crosstie in a supported joint must be in the middle location. The yellow dot on the crosstie is a carrier-used method of indicating that the crosstie must be removed. A tie plate was also missing at this joint.

An unspiked new crosstie was found at a location about 300 feet south of the point of derailment. (See figure 3.) Because of the absence of spikes in a number of the new crossties, many tie plates were not properly positioned under the rail base. (See figure 4.) Federal regulations require that tie plates having shoulders must be placed so that no part of the shoulder is under the base of the rail.

Four adjacent defective crossties--two were split and two were missing spikes--were found at the accident site, leaving a space of 109 inches between nondefective crossties. (See figure 5.) This exceeded the 70 inches maximum for nondefective crosstie spacing for Class 3 track allowed by the track safety standards (49 CFR 213.109(c)).

Five days after the derailment, the FRA issued violation notices on the two defects at mileposts 20.7 and 28.5 that had been reported to the ICG on July 22, 1980, and which had not been repaired in accordance with the track safety standards (49 CFR 213.233(d)).

After the accident, the disturbed rails were reassembled by ICG personnel. However, a 20-foot-long piece of rail that had been originally positioned as a part of the outside rail near the middle of the curve body could not be found. All other rails were carefully examined and found to be free of internal defects. Derailed wheel markings were found on the gage side of the outside rail about 74 feet from the beginning of the curve or about 216 feet north of signal 27.2.

<u>Train Speed.</u>--Several days after the accident, ICG personnel programmed the train makeup and routing data of train No. 64 into a company-owned computer and simulated runs from Cecilia to Muldraugh. Allowing for slow orders and other known conditions, they concluded that train No. 64 had been operated on the accident date at speeds averaging 6 mph over the authorized speed of 30 mph. A company supervising locomotive engineer who assisted in the testing said that the speed of the simulated movement increased by 4 mph in descending the 1.1 percent grade at the derailment site. A 12-pound brakepipe reduction as reported by the engineer of train No. 64 was used in the simulated descent.

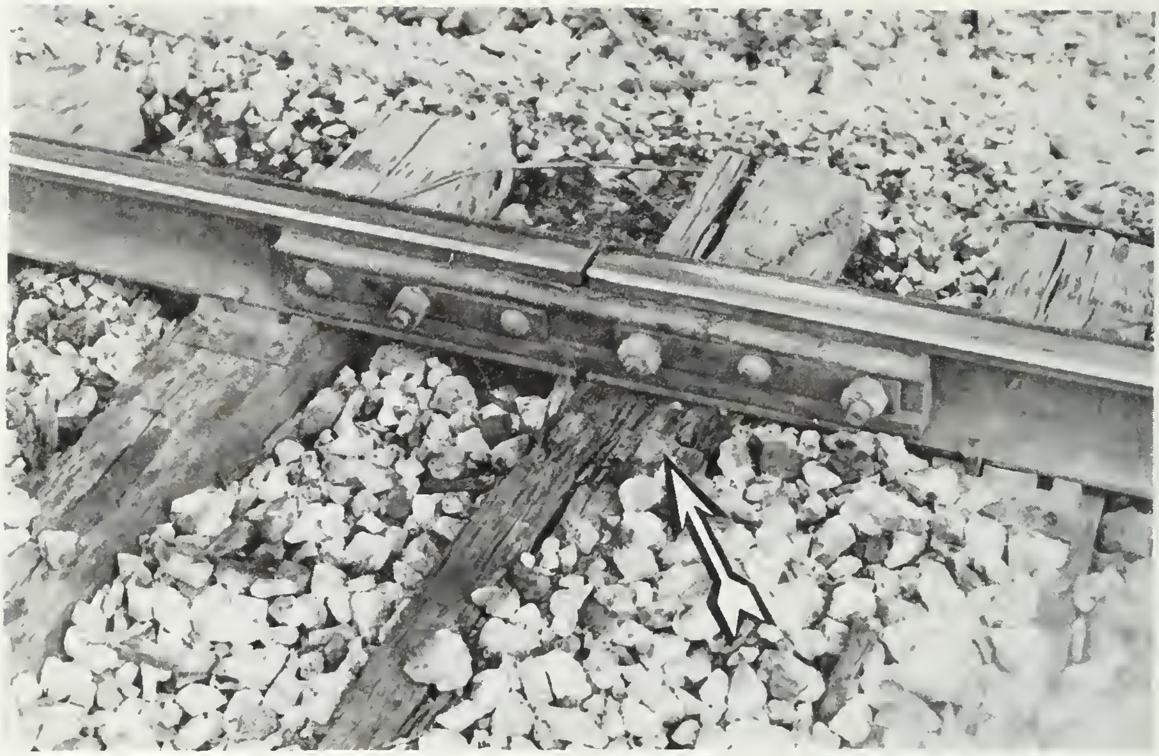


Figure 2.—Defective crosstie marked by yellow dot (arrow) 216 feet before the point of derailment.

Figure 3.—Unspiked new crosstie about 300 feet south of the point of derailment.

Figure 4.—Improperly installed and unspiked tieplates in derailment area.

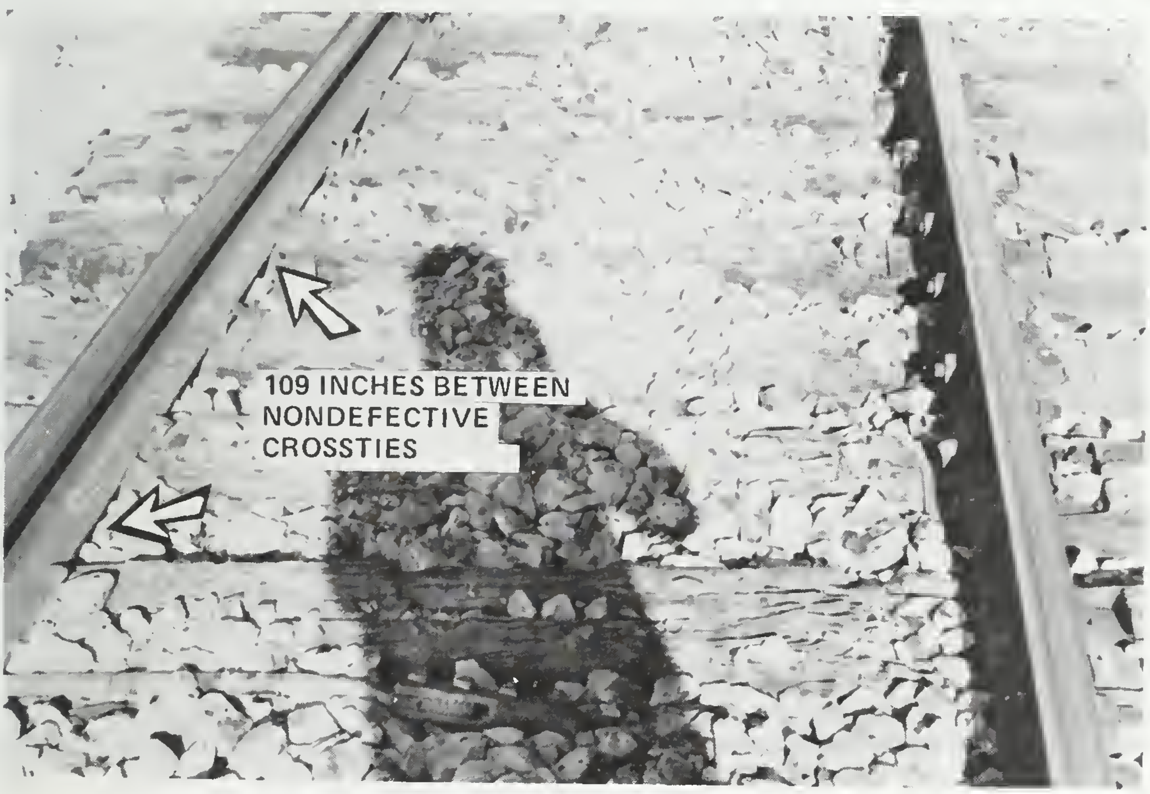


Figure 5.--Four adjacent defective crossties at the accident site.

ANALYSIS

The Accident

It is apparent from the marks on the track structure and from the location of the derailed equipment that train No. 64 derailed within the track gage at Muldraugh. The outside rail of the curve was tipped outward as the trailing truck of the lead locomotive unit entered the spiral of the 6° curve. This was evident from the rail abrasions seen on the wheels of this locomotive unit. The "popping" sound and a subsequent "fishtailing" of the lead unit described by the crewmembers resulted as the lead unit derailed at a point about 216 feet north of signal No. 27.2. The location where the crewmembers heard the popping sound coincided with the location of derailment markings on the rails. Therefore, the Safety Board concludes that the initial point of derailment was about 1,700 feet north of milepost 28.

The momentum of the derailed four-unit locomotive caused it to move on the track structure a distance of 428 feet, breaking rails, joint bars, and tie plates as the rails were forced outward by the wheels as they moved within the track gage. This destruction of the track structure then caused the locomotive to swing to the west as it left the track structure. After traveling an additional 219 feet, the four locomotive units overturned to the west.

Tank Car Structural Integrity

Tank head shields, top-and-bottom shelf couplers, and additional insulation previously recommended by the Safety Board 1/ were provided on the tank cars containing vinyl chloride. These components greatly enhanced the crashworthiness of the chemically laden tank cars during and after the derailment. Physical markings seen on the derailed equipment demonstrated that the path of metal-piercing projectiles had been diverted from the tank heads by the head shields. The postcrash equipment inspection indicated that top-and-bottom shelf couplers had performed within the limits of their designed functions. The J-type retrofit modifications which included metal jackets and insulation limited the flame impingement experienced by the vinyl chloride-filled tank cars to the outer jackets. Insulation further restricted the introduction of heat to the inner tank shells and their contents, preventing hot spots and allowing a controlled safety valve release of the gas. Catastrophic releases of hazardous materials did not occur.

Track Irregularities

Because of the extensive damage caused by the derailment, a complete assessment of the disturbed trackage was not possible. However, it is reasonable to assume that the conditions observed on the track in approach to and beyond the derailment area during a postaccident inspection were representative of the precrash conditions of the accident-damaged track. Also, the December 1979

1/ Safety Effectiveness Evaluation, "Analysis of Proceedings of the National Transportation Safety Board into Derailments and Hazardous Materials, April 4-6, 1978" (NTSB-SEE-78-2).

measurements of the track made by the FRA geometry car revealed abrupt changes in curvature and superelevation for a distance of about 84 feet at the beginning of the 6° curve. The variations of the 6° curve alignment from 5°30' to as much as 7° would have produced additional lateral forces on the outside rail of the curve as a train moved around the curve. Abrupt changes in the superelevation also would have produced unequal lateral forces. Even though these measurements were made about 6 months before the accident, there is no record that the repairs were made to correct these conditions before the accident occurred. Separately, these defects were not in violation of the standards for Class 3 track. However, constant traffic would, in all likelihood, have made the deviations greater than when originally measured. The increased possibility of derailment because of the combination of these deteriorating track conditions should have been recognized by inspectors.

As a result of its safety effectiveness evaluation of FRA track safety programs, 2/ the Safety Board recommended on March 20, 1979, that the FRA:

> Immediately revise the track safety standards to eliminate the subjectivity, incompatibility, vagueness, and unenforceability. The requirements should be made more explicit so as to insure the detection and correction of all combinations of track conditions which cause derailments. (R-79-19)

The FRA replied that it had undertaken, beginning in May 1978, a complete review of the track safety standards in an effort to reduce the number of, and to strengthen and clarify, those portions remaining as requirements. However, the review and revision of the standards has not yet been completed. The Safety Board is holding this recommendation in an "Open--Acceptable Action" status.

Over 90 percent of the Louisville District trackage had been downgraded by the carrier from FRA Class 4 to Class 3. At the accident site, deteriorated track conditions indicate the carrier had apparently maintained the Class 3-designated trackage at no more than a minimum level of compliance. However, certain defects found on the track structure near the derailment site, such as excessive spacing between nondefective crossties, improper tie plate positioning, and an improperly supported joint, were in violation of the standards prescribed for Class 3 tracks. Although most of the other track irregularities observed near the site were permitted by FRA standards for Class 3 track, collectively all these irregularities, with other system stresses, most likely caused the track to fail.

The Board's 1979 safety effectiveness evaluation also discussed the problems associated with lowering a track classification in lieu of making necessary repairs to maintain the track's higher classification. As a result, the Safety Board recommended that the FRA:

> Determine the ultimate safety effect of allowing the indiscriminate lowering of main track classifications instead of maintaining the track at original intended class. (R-79-25)

2/ "Safety Effectiveness Evaluation of the Federal Railroad Administration's Hazardous Materials and Track Safety Programs, March 8, 1979" (NTSB-SEE-79-2)

The FRA replied that safety should not be affected by lowering of main track classification. It said that a study of the relationship between train loading, train speeds, and track conditions is reflected in the revised track safety standards published in a notice of proposed rulemaking on September 6, 1979. In the notice of proposed rulemaking, the FRA stated in the section "Classes of Track: Operating Speed Limits" that consideration of axle loads in determining maximum permissible operating speeds was being postponed until further technical information provided sufficient safety justification for this step, or future investigation revealed significant cost reductions. The Safety Board is holding this recommendation in an "Open—Unacceptable Action" status.

Section 213.9 of the proposed rule prescribes maximum permissible speeds that are correlated to the strength or weight of the rail in the track. Since dynamic forces generated by passage of both freight and passenger trains increase as train speed increases, with rail support conditions remaining constant, the stresses developed in the rail will likewise increase. Heavier rail is needed to sustain these higher forces. Thus, the FRA proposes to lower many of the present maximum permissible speeds over the various classes of track that have rail weighing less than 112 pounds per yard and to increase the maximum permissible speeds over track with rail that weighs more than 131 pounds per yard. The maximum permissible speeds over track with rails that weigh between 112 and 131 pounds per yard would remain essentially the same. The Safety Board on January 10, 1980, in its comments on the proposed rulemaking stated that in revising section 213.9, speed limits should not be raised solely on the basis of weight of rail. The Board said that there are other criteria, such as crosstie condition, cross level, and gage, which should be considered. The Board stated its concern that the proposal could effectively raise many train speeds without compensating changes in track geometry requirements.

Many excessively curve-worn rails were found throughout the derailment area. The approximate 28- to 44-percent reduction in the cross section of the rail would have substantially lowered the rail's ability to withstand bending stresses. 3/ This worn condition would have made the rail more prone to breakage under the strain of the increasingly heavy loads carried by today's trains. 4/ A 44-percent reduction of cross section also would have made the rail more prone to tipping because the resultant force of the vertical and lateral component forces of the wheel on the rail could have been beyond the outside edge of the rail base. The use of such curve-worn rails is left to the discretion of the carrier. Neither the ICG nor the FRA have promulgated rules or regulations to limit wear for rails that are used in mainline trackage. The Safety Board believes that the use of such excessively worn rails should not be used on main or side tracks.

3/ "Track Structures for Heavy Wheel Loads," William W. Hay, 1975 Railroad Engineering Conference.

4/ National Transportation Safety Board, Atlanta Field Office, Field Report of Railroad Accident Investigation--Louisville and Nashville Railroad Company Freight Train Derailment at Acworth, Georgia, January 25, 1980 (ATL-80-FR-002).

An inspection of the rail and crossties as a result of the 1-inch-wide gage recorded on the 6° curve by the FRA geometry car on December 14, 1979 indicated a problem with the track holding proper gage. Additionally, the FRA track safety inspector on July 22, 1980, cautioned the ICG track supervisor that excessive gage-widening was possible because of the wear condition seen on the curved rails. Allowing the excessively curve-worn rails to remain in the mainline track significantly increased the risk of derailment and of possible injurious consequences from hazardous materials to the Muldraugh/Fort Knox communities. If there were either a responsible policy by the ICG or if there had been Federal regulations limiting the use of such badly worn rails in mainline track, the accident may have been prevented by correction of the worn rail condition and other existing track irregularities at the same time.

Many of the crossties in the derailment area were defective and were scheduled for replacement by the carrier shortly after the date of this accident. The crossties were split and spike-worn to the extent that they would not provide sufficient securement for the rails. In addition, the rails had not been spiked to some of the new crossties which had been put in place 6 months before the accident. In advance of the derailment area, crossties were missing in several places, thus allowing excessive spacing between crossties. This deteriorated crosstie condition along with an excessively worn rail condition could have created a track condition which would have been unable to sustain the normal lateral forces of a passing train such as train No. 64. These normal forces would probably have caused the outside rail in the curve to tip under the locomotive.

FRA Track Safety Standards

The Safety Board has addressed the deficiencies of the FRA track safety standards in other accident reports. 5/ This accident, involving a hazardous materials release, emphasizes the urgent need to revise the existing standards to provide for a safe track. Many of the track irregularities found at the time of this derailment were acceptable deviations under the established Federal standards. Other irregularities, such as the condition and location of the crossties under supported joints, either were not subject to regulation or were subject to a difference in interpretation or a combination of conditions. The lack of clear and specific regulations and the failure of the regulations to take into account the cumulative effect of a combination of deficiencies prompts judgmental safety decisions to be made by those who otherwise might rigidly adhere to restrictions imposed by Federal regulation.

Under the current FRA track safety standards, specified civil penalties are established for noncompliance with the minimum safety requirements. However, before such penalties can be imposed, it must be demonstrated that the carrier had prior knowledge of the track conditions that are in noncompliance. In its special study of the proposed track standards prior to their effective date, 6/ the Safety

5/ "Railroad Accident Report--Derailment of Amtrak Train on Illinois Central Gulf Railroad, Goodman, Mississippi, June 30, 1976" (NTSB-RAR-77-3), and "Railroad Accident Report--Derailment of Amtrak Train on Burlington Northern Railroad, near Ralston, Nebraska, December 16, 1976" (NTSB-RAR-77-8).
6/ "Railroad Special Study--Proposed Track Safety Standards, August 26, 1971" (NTSB-RSS-71-2).

Board discussed the inadequacy of section 213.5, which does not require that all substandard or defective conditions actually be searched out and corrected. This loophole allows, and may even promote, the practice of deferring track maintenance to the point where it becomes unsafe. The safety regulations neither encourage carriers to improve track above the regulatory minimums nor discourage violations of regulations by the prospect of effective enforcement. When an FRA track safety inspector finds noncompliance with the regulations, he must inform a carrier representative of the infraction. At that time, several options are permitted by the regulations which allow the carrier to bring the track into compliance before a penalty is imposed. In most cases, the carrier merely elects to downgrade the affected track to the next lower class until repairs are made or the carrier may even defer repair indefinitely. Because of the thousands of miles of trackage for which each of the few FRA track safety inspectors is responsible, a railroad's track maintenance procedures which allow irregularities to exist will be continued by some carriers without a real threat of Federally imposed penalties.

The circumstances of the Muldraugh derailment show the need for closer FRA monitoring of current ICG track inspection and maintenance practices. Additionally, this accident indicates that beyond the revisions of the FRA track safety standards suggested by the Safety Board in the past, revision should be made to include (1) new regulations that define and restrict certain combinations of track irregularities that create unacceptable risks to safe train operations, (2) establishment of rail limits of wear that will exclude the use of excessively worn rails in mainline tracks subject to use by trains carrying passengers or hazardous materials, and (3) an elimination of the "need to know" requirement of defective conditions as a basis for penalty. There should also be a tightening of the civil penalty regulations to influence carriers to adhere more rigidly to Federal track maintenance requirements.

Train Speed

When train No. 64's locomotive crew assumed control of the locomotive consist at Central City, there was nothing in the transfer reports to suggest that the speed indicator was inaccurate. The speed indicator was checked in accordance with existing instructions, and the crew assumed that the indicator was performing accurately. Since there were no other measured-mile stations prior to the accident site, the crew was unable to make additional tests. However, postaccident tests indicated that the actual train speed was faster than that shown by the speed indicator. Train No. 64 traveled the 19 miles between Cecilia and Muldraugh in 1 hour 6 minutes. Complying with the maximum speeds allowed for this trackage, the trip should have taken 1 hour 21 minutes. The fireman who was operating the train had relied completely on the inaccurate speed indicator reading of about 5 mph slower than actual to comply with the authorized track speeds. Therefore, the speed at the time of the derailment could have been as much as 35 mph since the fireman thought he was operating the train between 26 and 30 mph as the train entered the curve. The 35-mph speed of train No. 64 at the time of the accident could have been an additional contributing factor, particularly with the track in a deteriorated condition.

Postderailment Activities

The Safety Board commends the manner in which the State of Kentucky, the U.S. Army, various Federal agencies, surrounding communities, and the ICG conducted emergency on-site activities. Through their coordinated efforts, the threat of serious injuries to the public was minimized. If the derailment had produced more catastrophic consequences, its location relative to the Fort Knox military installation could have caused significant evacuation and security problems.

CONCLUSIONS

Findings

1. The lead unit of train No. 64's locomotive was the first to derail.

2. The initial point of derailment was about 1,700 feet north of milepost 28.

3. Broken rails, joint bars, and tie plates at the accident site resulted from the derailment.

4. The locomotive speed indicator used by the fireman to control the train's speed indicated as much as 5.1 mph less than actual train speed.

5. At the time of the derailment, train No. 64 was moving at about 35 mph in a 30-mph speed restriction location. This speed should not have affected an adequate track structure.

6. The combination of track irregularities in alignment, profile, cross level, and curve-worn rail conditions combined with train speed to produce sufficient lateral forces to tip the high rail and widen the track gage.

7. The current FRA track safety standards do not take into consideration the cumulative effect of combinations of otherwise acceptable track irregularities on safe train operations.

8. The FRA track safety standards do not restrict the use of curve-worn rails, except through those regulations regarding proper track gage.

9. The ICG elected to downgrade the track classification of the Louisville subdivision rather than to repair and maintain it as a Class 4 track.

10. After receiving notice of noncompliance from an FRA inspector, ICG personnel failed to repair the two track defects in the Muldraugh area prior to the derailment.

11. Many deviations from the FRA track safety standards were overlooked during an FRA safety inspection of the trackage near Muldraugh 4 days before the accident.

12. Track conditions at the accident site indicated that the ICG's prederailment maintenance practices did not produce a track condition which met the minimum requirements for Class 3 track.

13. Postaccident emergency activities were carried out in a coordinated and effective manner by all participants.

14. Top-and-bottom shelf couplers, tank head shields, and tank shell insulation performed within design limits as intended and prevented head punctures in all of the derailed tank cars.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the tipping of the outside rail and widening of track gage in the 6° curve because of the combined effects of defective crossties, excessively worn rail, irregular alignment and gage, and the lateral forces produced by the train's speed. Inadequate maintenance and inspection practices of the Illinois Central Gulf Railroad allowed these conditions to remain uncorrected. Contributing to the accident was the inadequate Federal Track Safety Standards which failed to provide for a track structure commensurate with the permitted train speeds.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommends that:

-the Illinois Central Gulf Railroad Company:

Establish and implement procedures to maintain mainline tracks and sidings to a level of safety not less than that which is prescribed by Federal regulations governing carrier-designated track classes. (Class II, Priority Action) (R-81-32)

Establish and implement track maintenance standards which designate the limit of acceptable rail wear and which require rail removal when worn beyond the acceptable limits. (Class II, Priority Action) (R-81-33)

-the Federal Railroad Administration:

Institute surveillance of the maintenance of Louisville District trackage of the Illinois Central Gulf Railroad Company until it is brought into conformance with the requirements of the FRA track safety standards. (Class II, Priority Action) (R-81-34)

Promulgate regulations which designate the limit of acceptable rail wear and which require railroads to remove from active tracks rails that are worn beyond the acceptable limits. (Class II, Priority Action) (R-81-35)

In addition, the National Transportation Safety Board reiterates the following recommendations previously made to the Federal Railroad Administration as a result of other train accident investigations:

> Amend track geometry standard 49 CFR 213.55, Alignment, so that it defines "uniformity," establishes a maximum rate-of-change in alignment deviation, and establishes the maximum number of feet between which each alignment mid-offset measurement shall be taken. (R-77-6) (Open—Response Received)
>
> Amend track geometry standard 49 CFR 213.63, Track Surface, so that it defines "uniform profile," establishes maximum rate-of-change in profile and cross level deviations, and establishes the maximum number of feet between which each profile midordinate measurement and each cross level measurement shall be taken. (R-77-7) (Open—Response Received)
>
> Include in review of the current FRA track safety regulations, investigation and testing to determine if the minimum track conditions that are required for the FRA classes of track by 49 CFR 213.9 are adequate for all types of trains for the maximum allowable speed for each class. (R-77-8) (Open—Acceptable Action)
>
> Immediately revise the track safety standards to eliminate the subjectivity, incompatibility, vagueness, and unenforceability. The requirements should be made more explicit so as to insure the detection and correction of all combinations of track conditions which cause derailments. (R-79-19) (Open—Acceptable Action)
>
> Determine the ultimate safety effect of allowing the indiscriminate lowering of main track classifications instead of maintaining the track at original intended class. (R-79-25) (Open--Acceptable Action)
>
> Amend track safety standards 49 CFR 213.241, Inspection Records, to require railroad inspectors to list on their inspection records the location of rails which exhibit the external conditions listed in subpart (b) of 49 CFR 213.113, Defective Rails, and the remedial action they have taken. (R-80-32) (Open—Response Received)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

February 3, 1981

APPENDIXES

APPENDIX A
INVESTIGATION

Investigation

The National Transportation Safety Board was notified of the accident about 11:30 a.m., on July 26, 1980. The Safety Board immediately dispatched an investigative team from its field office in Atlanta, Georgia, to the scene. On August 20, 1980, statements about the accident were taken in Louisville, Kentucky, from ICG employees.

APPENDIX B
CREWMEMBER INFORMATION

C. S. Wheat, Locomotive Engineer

Mr. Wheat, age 31, was employed as a fireman on October 30, 1969. He was promoted to locomotive engineer on September 11, 1970. He passed a medical examination on May 13, 1970, and passed the ICG operating rules examination last held in 1978. He was sitting in the fireman's seat when the accident occurred.

William L. Hunt, Fireman

Mr. Hunt, age 37, was employed as a switchman on March 25, 1970. He transferred to brakeman on March 25, 1971, and transferred to fireman on July 10, 1973. On July 31, 1973, he was promoted to conductor. On June 25, 1974, he was examined on the operating rules as a student engineer and was promoted to locomotive engineer on July 1, 1974. He passed a medical examination on July 10, 1980, to return to work from a personal injury. He passed the ICG operating rules examination last held in 1978. He was operating the locomotive when the accident occurred.

Jerry L. Tucker, Head Brakeman

Mr. Tucker, age 27, was employed as a brakeman on May 13, 1972, and was promoted to conductor on May 18, 1974. He passed the ICG operating rules examination last held in 1978. When the derailment occurred, he was seated in the left-front seat of the locomotive.

C. L. Gregory, Conductor

Mr. Gregory, age 58, was employed as a brakeman on December 4, 1941. He took a 3-year military leave and returned to work on December 28, 1945. He was promoted to conductor on March 27, 1950. He passed a medical examination on September 24, 1974, and was required to wear eyeglasses while on duty. He passed the ICG operating rules examination last held in 1978. He was on the caboose when the train derailed.

John O. Randolph, Rear Brakeman

Mr. Randolph, age 31, was employed as a brakeman on May 21, 1969, and was promoted to conductor on September 23, 1973. He passed the ICG operating rules examination last held in 1978. He was riding on the caboose when the derailment occurred.

APPENDIX C
EXCERPTS FROM TRACK SAFETY STANDARDS
49 CFR 213

SUBPART A—GENERAL

§ 213.1 SCOPE OF PART.

This part prescribes initial minimum safety requirements for railroad track that is part of the general railroad system of transportation. The requirements prescribed in this part apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to provide for safe operations over that track.

*****

§ 213.9 CLASSES OF TRACK: OPERATING SPEED LIMITS.

(a) Except as provided in paragraph (b) of this section and §§ 213.57(b), 213.59(a), 213.105, 213.113 (a) and (b), and 213.137 (b) and (c), the following maximum allowable operating speeds apply:

[In miles per hour]

Over track that meets all of the requirements prescribed in this part for —	*The maximum allowable operating speed for freight trains is —*	*The maximum allowable operating speed for passenger trains is —*
Class 1 track . .	10	15
Class 2 track . .	25	30
Class 3 track . .	40	60
Class 4 track . .	60	80
Class 5 track . .	80	90
Class 6 track . .	110	110

(b) If a segment of track does not meet all of the requirements for its intended class, it is reclassified to the next lowest class of track for which it does meet all of the requirements of this part. However, if it does not at least meet the requirements for class 1 track, no operations may be conducted over that segment except as provided in § 213.11.

*****

§ 213.11 RESTORATION OR RENEWAL OF TRACK UNDER TRAFFIC CONDITIONS.

If, during a period of restoration or renewal, track is under traffic conditions and does not meet all of the requirements prescribed in this part, the work and operations on the track must be under the continuous supervision of a person designated under § 213.7(a).

§ 213.13 MEASURING TRACK NOT UNDER LOAD

When unloaded track is measured to determine compliance with requirements of this part, the amount of rail movement, if any, that occurs while the track is loaded must be added to the measurement of the unloaded track.

*****

SUBPART C—TRACK GEOMETRY

§ 213.51 SCOPE.

This subpart prescribes requirements for the gage, alinement, and surface of track, and the elevation of outer rails and speed limitations for curved track.

§ 213.53 GAGE.

(a) Gage is measured between the heads of the rails at right angles to the rails in a plane five-eighths of an inch below the top of the rail head.

(b) Gage must be within the limits prescribed in the following table:

Class of track	*The gage of tangent track must be—*		*The gage of curved track must be—*	
	At least—	*But not more than—*	*At least—*	*But not more than—*
1	4'8"	4'9¾"	4'8"	4'9¾"
2 and 3 . . .	4'8"	4'9½"	4'8"	4'9¾"
4	4'8"	4'9¼"	4'8"	4'9½"
5	4'8"	4'9"	4'8"	4'9½"
6	4'8"	4'8¾"	4'8"	4'9"

*****

§ 213.63 TRACK SURFACE.

Each owner of track to which this part applies shall maintain the surface of its track within the limits prescribed in the following table:

APPENDIX C

Track Surface	Class of track					
	1	2	3	4	5	6
The runoff in any 31 feet of rail at the end of a raise may not be more than	3½"	3"	2"	1½"	1"	½"
The deviation from uniform profile on either rail at the midordinate of a 62-foot chord may not be more than	3"	2¾"	2¼"	2"	1¼"	½"
Deviation from designated elevation on spirals may not be more than	1¾"	1½"	1¼"	1"	¾"	½"
Variations in cross level on spirals in any 31 feet may not be more than	2"	1¾"	1¼"	1"	¾"	½"
Deviation from zero cross level at any point on tangent or from designated elevation on curves between spirals may not be more than	3"	2"	1¾"	1¼"	1"	½"
The difference in cross level between any two points less than 62 feet apart on tangents and curves between spirals may not be more than	3"	2"	1¾"	1¼"	1"	⅝"

*****

§ 213.55 ALINEMENT.

Alinement may not deviate from uniformity more than the amount prescribed in the following table:

Class of track	Tangent track — The deviation of the mid-offset from 62-foot line[1] may not be more than—	Curved track — The deviation of the mid-ordinate from 62-foot chord[2] may not be more than—
1	5"	5"
2	3"	3"
3	1¾"	1¾"
4	1½"	1½"
5	¾"	⅝"
6	½"	⅜"

[1] The ends of the line must be at points on the gage side of the line rail, five-eighths of an inch below the top of the railhead. Either rail may be used as the line rail, however, the same rail must be used for the full length of that tangential segment of track.

[2] The ends of the chord must be at points on the gage side of the outer rail, five-eighths of an inch below the top of the railhead.

*****

SUBPART D—TRACK STRUCTURE

§ 213.101 SCOPE.

This subpart prescribes minimum requirements for ballast, crossties, track assembly fittings, and the physical condition of rails.

§ 213.105 BALLAST; DISTURBED TRACK.

If track is disturbed, a person designated under § 213.7 shall examine the track to determine whether or not the ballast is sufficiently compacted to perform the functions described in § 213.103. If the person making the examination considers it to be necessary in the interest of safety, operating speed over the disturbed segment of track must be reduced to a speed that he considers safe.

§ 213.109 CROSSTIES.

(a) Crossties may be made of any material to which rails can be securely fastened. The material must be capable of holding the rails to gage within the limits prescribed in § 213.53 (b) and distributing the load from the rails to the ballast section.

(b) A timber crosstie is considered to be defective when it is—

(1) Broken through;

(2) Split or otherwise impaired to the extent it will not hold spikes or will allow the ballast to work through;

(3) So deteriorated that the tie plate or base of rail can move laterally more than one-half inch relative to the crosstie;

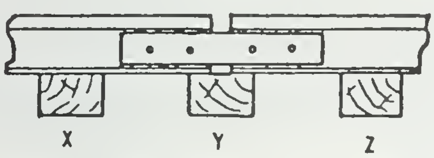
(4) Cut by the tie plate through more than 40 percent of its thickness; or

(5) Not spiked as required by § 213.127.

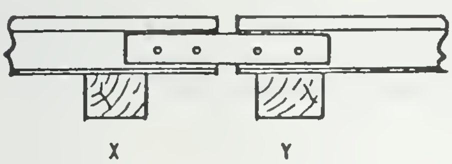
(c) If timber crossties are used, each 39 feet of track must be supported by nondefective ties as set forth in the following table:

Class of track	*Minimum number of nondefective ties per 39 feet of track*	*Maximum distance between nondefective ties (center to center) (inches)*
1	5	100
2, 3	8	70
4, 5	12	48
6	14	48

(d) If timber ties are used, the minimum number of nondefective ties under a rail joint and their relative positions under the joint are described in the following chart. The letters in the chart correspond to letter underneath the ties for each type of joint depicted.



Supported joint



Suspended joint

Class of Track	*Minimum number of nondefective ties under a joint*	*Required position of nondefective ties*	
		Supported Joint	*Suspended Joint*
1	One	X, Y, or Z	X or Y.
2, 3	One	Y	X or Y.
4, 5, 6	Two	X and Y, or Y and Z.	X and Y.

(e) Except in an emergency or for a temporary installation of not more than 6 months duration, crossties may not be interlaced to take the place of switch ties.

§ 213.123 Tie plates.

(a) In classes 3 through 6 track where timber crossties are in use there must be tie plates under the running rails on at least eight of any 10 consecutive ties.

(b) Tie plates having shoulders must be placed so that no part of the shoulder is under the base of the rail.

§ 213.125 Rail anchoring.

Longitudinal rail movement must be effectively controlled. If rail anchors which bear on the sides of ties are used for this purpose, they must be on the same side of the tie on both rails.

§ 213.127 Track spikes.

(a) When conventional track is used with timber ties and cut track spikes, the rails must be spiked to the ties with at least one line-holding spike on the gage side and one line-holding spike on the field side. The total number of track spikes per rail per tie, including plateholding spikes, must be at least the number prescribed in the following table:

Subpart F—Inspection

§ 213.231 Scope.

This subpart prescribes requirements for the frequency and manner of inspecting track to detect deviations from the standards prescribed in this part.

§ 213.233 Track inspections.

(a) All track must be inspected in accordance with the schedule prescribed in paragraph (c) of this section by a person designated under § 213.7.

(b) Each inspection must be made on foot or by riding over the track in a vehicle at a speed that allows the person making the inspection to visually inspect the track structure for compliance with this part. However, mechanical, electrical and other track inspection devices may be used to supplement visual inspection. If a vehicle is used for visual inspection, the speed of the vehicle may not be more than 5 miles per hour when passing over track crossings, highway crossings, or switches.

(c) Each track inspection must be made in accordance with the following schedule:

APPENDIX C

Class of track	Type of track	Required frequency
1, 2, 3	Main track and sidings	*Weekly* with at least 3 calendar days interval between inspections, or *before use*, if the track is used less than once a week, or *twice weekly* with at least 1 calendar day interval between inspections, if the track carries passenger trains or more than 10 million gross tons of traffic during the preceding calendar year
1, 2, 3	Other than main track and sidings	*Monthly* with at least 20 calendar days interval between inspections
4, 5, 6		*Twice weekly* with at least 1 calendar day interval between inspections

(d) If the person making the inspection finds a deviation from the requirements of this part, he shall immediately initiate remedial action.

§ 213.235 Switch and track crossing inspections.

(a) Except as provided in paragraph (b) of this section, each switch and track crossing must be inspected on foot at least monthly.

(b) In the case of track that is used less than once a month, each switch and track crossing must be inspected on foot before it is used.

§ 213.237 Inspection of rail.

(a) In addition to the track inspections required by § 213.233, at least once a year a continuous search for internal defects must be made of all jointed and welded rails in Classes 4 through 6 track, and Class 3 track over which passenger trains operate. However, in the case of a new rail, if before installation or within 6 months thereafter, it is inductively or ultrasonically inspected over its entire length and all defects are removed, the next continuous search for internal defects need not be made until 3 years after that inspection.

(b) Inspection equipment must be capable of detecting defects between joint bars, in the area enclosed by joint bars.

(c) Each defective rail must be marked with a highly visible marking on both sides of the web and base.

§ 213.239 Special inspections.

In the event of fire, flood, severe storm, or other occurrence which might have damaged track structure, a special inspection must be made of the track involved as soon as possible after the occurrence.

§ 213.241 Inspection records.

(a) Each owner of track to which this part applies shall keep a record of each inspection required to be performed on that track under this subpart.

(b) Each record of an inspection under §§ 213.233 and 213.235 shall be prepared on the day the inspection is made and signed by the person making the inspection. Records must specify the track inspected, date of inspection, location and nature of any deviation from the requirements of this part, and the remedial action taken by the person making the inspection. The owner shall retain each record at its division headquarters for at least 1 year after the inspection covered by the record.

(c) Rail inspection records must specify the date of inspection, the location, and nature of any internal rail defects found, and the remedial action taken and the date thereof. The owner shall retain a rail inspection record for at least 2 years after the inspection and for 1 year after remedial action is taken.

(d) Each owner required to keep inspection records under this section shall make those records available for inspection and copying by the Federal Railroad Administrator.

APPENDIX C

Appendix A—Maximum Allowable Operating Speeds for Curved Track

Elevation of outer rail (inches)

Degree of Curvature	0	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
	Maximum allowable operating speed (mph)												
0°30'	93	100	107										
0°40'	80	87	93	98	103	109							
0°50'	72	78	83	88	93	97	101	106	110				
1°00'	66	71	76	80	85	89	93	96	100	104	107	110	
1°15'	59	63	68	72	76	79	83	86	89	93	96	99	101
1°30'	54	58	62	66	69	72	76	79	82	85	87	90	93
1°45'	50	54	57	61	64	67	70	73	76	78	81	83	86
2°00'	46	50	54	57	60	63	66	68	71	73	78	78	80
2°15'	44	47	50	54	56	59	62	64	67	69	71	74	76
2°30'	41	45	48	51	54	56	59	61	63	66	68	70	72
2°45'	40	43	46	48	51	54	56	58	60	62	65	66	68
3°00'	38	41	44	46	49	51	54	56	58	80	62	64	66
3°15'	36	39	42	45	47	49	51	54	56	57	59	81	63
3°30'	35	38	40	43	45	47	50	52	54	55	57	59	61
3°45'	34	37	39	41	44	46	48	50	52	54	55	57	59
4°00'	33	35	38	40	42	44	46	48	50	52	54	55	57
4°30'	31	33	36	38	40	42	44	45	47	49	50	52	54
5°00'	29	32	34	36	38	40	41	43	45	46	48	49	51
5°30'	28	30	32	34	36	38	40	41	43	44	46	47	48
6°00'	27	29	31	33	35	36	38	39	41	42	44	45	46
6°30'	26	28	30	31	33	35	36	38	39	41	42	43	45
7°00'	25	27	29	30	32	34	35	36	38	39	40	42	43
8°00'	23	25	27	28	30	31	33	34	35	37	38	39	40
9°00'	22	24	25	27	28	30	31	32	33	35	36	37	38
10°00'	21	22	24	25	27	28	29	31	32	33	34	35	36
11°00'	20	21	23	24	26	27	28	29	30	31	32	33	34
12°00'	19	20	22	23	24	26	27	28	29	30	31	32	33

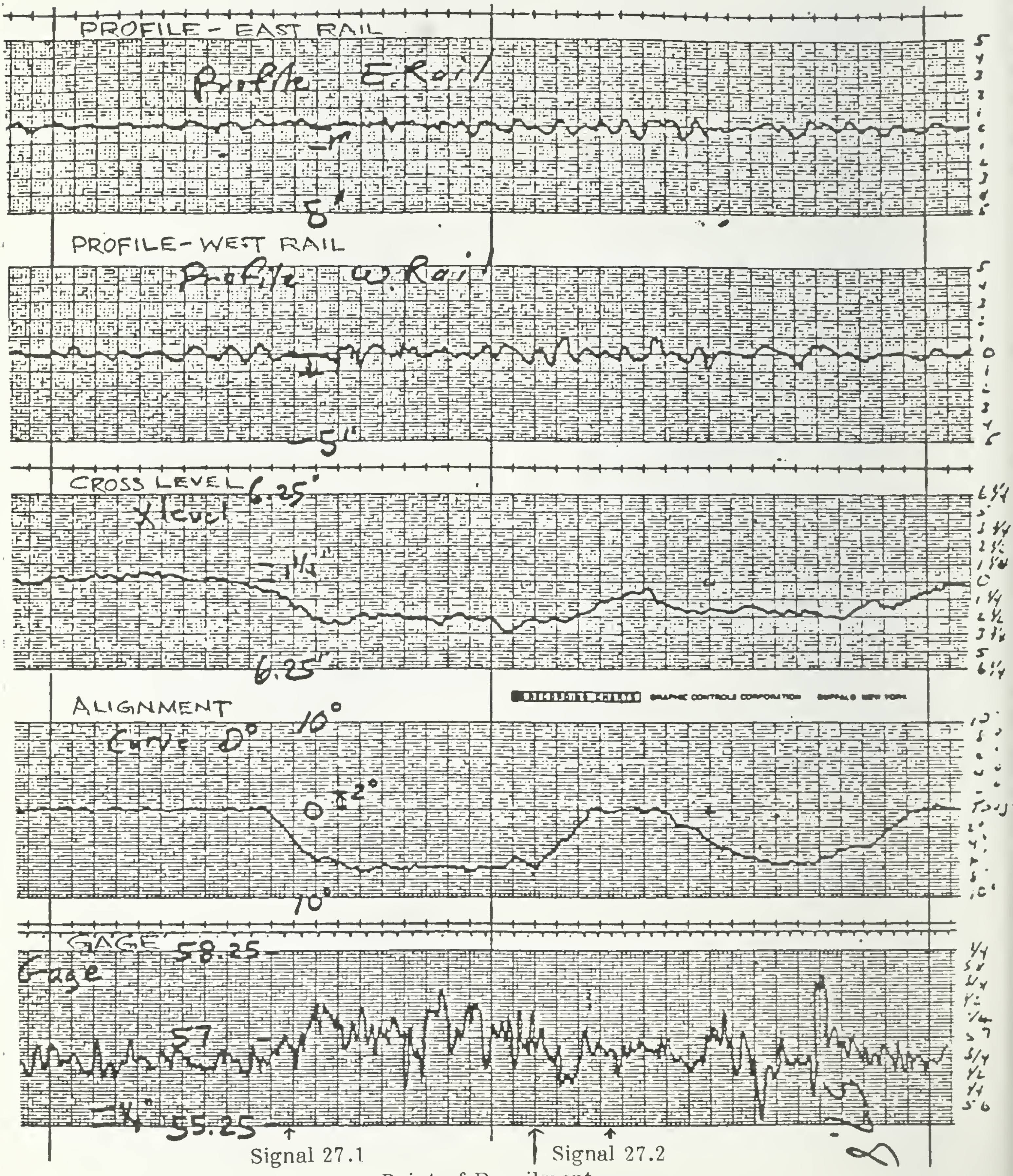
[36 FR 20336, Oct. 20, 1971, as amended at 38 FR 876, Jan. 5, 1973]

Appendix B—Schedule of Civil Penalties

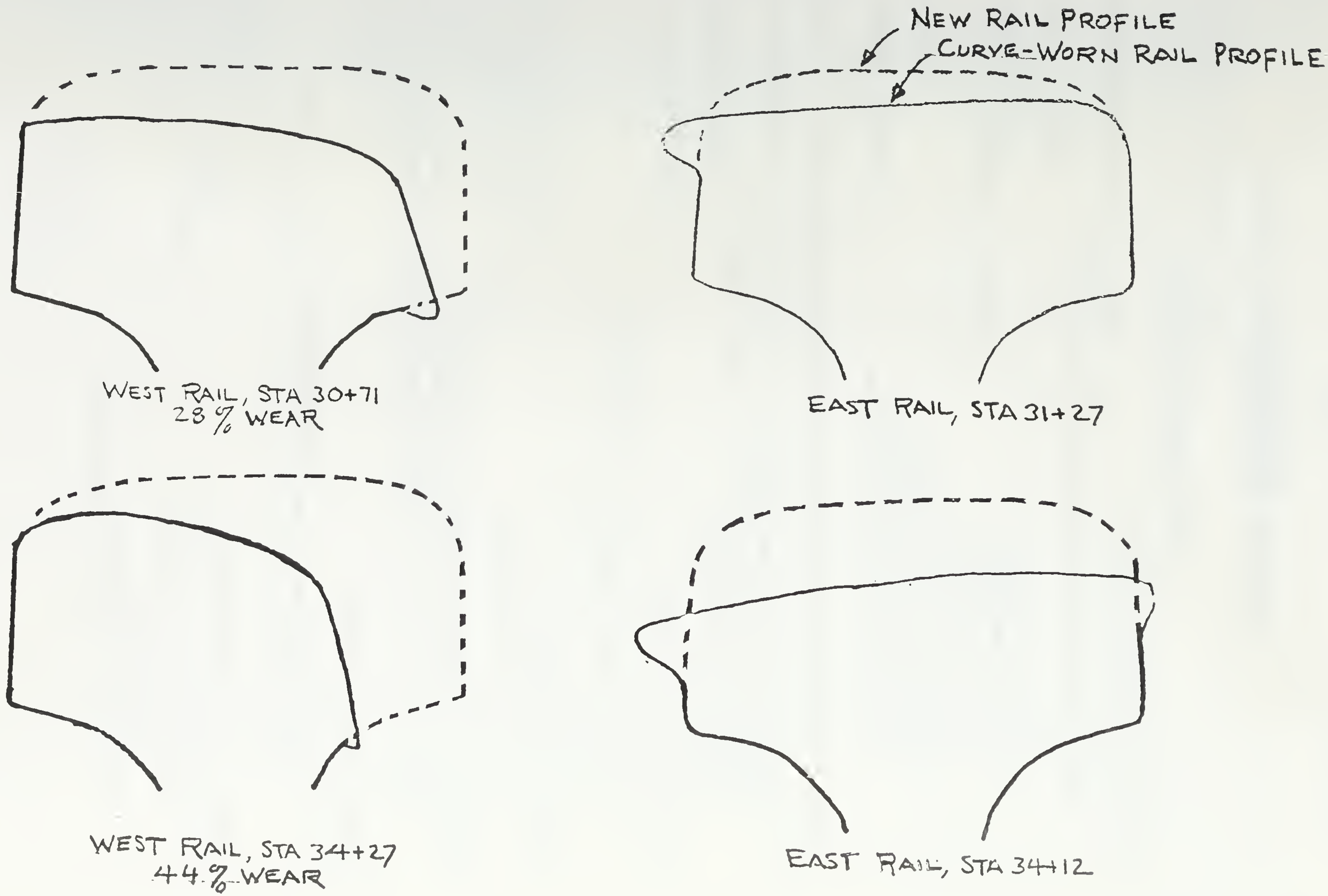
Appendix B reflects a statement of policy by the Federal Railroad Administration in making applicable to Part 213 a specific civil penalty for a violation of particular sections of this part.

		Violation	Haz viol
Subpart A—General			
213.5	Responsibility of track owners	$1,000	$2,000
213.7	Designation of qualified persons to supervise certain renewals and inspect track	500	1,000
213.9	Classes of track: operating speed limits	1,000	2,000
213.11	Restoration or renewal of track under traffic conditions	1,000	1,000
213.13	Measuring track not under load	500	1,000
Subpart B—Roadbed			
213.33	Drainage	500	1,000
213.37	Vegetation	500	1,000
Subpart C—Track geometry			
213.53	Gage	750	1,500
213.55	Alinement	750	1,500

APPENDIX D
FRA GEOMETRY TAPE, DECEMBER 14, 1979
ICG TRACK, MP 27 TO 28



APPENDIX E
PROFILE OF CURVE-WORN RAIL



APPENDIX F
AGENCIES RESPONDING TO ACCIDENT

State Agencies of Kentucky

Department of Military Affairs

Division of Disaster and Emergency Services (DES)

- Area 5 Coordinator
- Area 6 Coordinator
- Area 3 Coordinator
- Executive Director
- Public Information Officers
- Two Communications Officers
- Army National Guard-Helicopters

Department of Natural Resources and Environmental Protection

Division of Air Pollution Control
Division of Hazardous Materials and Waste Management
Division of Water Quality

Department of Agriculture

Division of Food Distribution

Department of Justice

Bureau of the State Police

Department of Housing, Buildings, and Construction

Office of the State Fire Marshal - Hazardous Materials Division

Department of Education

Bureau of Vocational Education-Public Service Occupations Unit
- Fire Services

Department of Human Resources

Bureau for Social Services
- Social Workers

Bureau for Health Services
- Health Environmentalists

Federal Agencies

U.S. Environmental Protection Agency

Environmental Emergencies Branch

National Transportation Safety Board

U.S. Army - Fort Knox

Military Police
Explosives Ordnance Detachment

U.S. Air Force

Weather Detachment

Department of Transportation

Federal Railroad Administration

Department of Justice

U.S. Marshals Service

Independent

Haz Tec
Illinois Central Gulf Railroad
Hulcher Emergency Services
Stauffer Chemical Company - Shipper
B. F. Goodrich - Shipper
Association of American Railroads, Bureau of Explosives
Valley Station High School - Louisville School System
American Red Cross
Salvation Army

Local Agencies

Hardin County DES
Hardin County DES Rescue
Louisville Fire Department
County Judge/Executive-Meade County
Meade County DES
Larue County DES
Louisville-Jeffersonville County Civil Preparedness
Muldraugh Police Department
Lebanon Junction Fire Department
Meade County Sheriff's Office
Mayor - Muldraugh
Muldraugh Fire Department
Grayson County DES

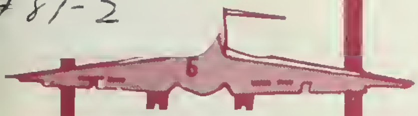
APPENDIX G
POSTACCIDENT TRACK MEASUREMENTS
JULY 28, 1980

STATION	ELEVATION	GAGE	ORDINATE
421+13.5	3/4"	56 1/2"	0"
+34.0	7/8"	56 1/2"	0"
+49.5	1"	56 5/8"	1/9"
+65.0	1"	56 3/8"	1/2"
+80.5	1 1/4"	56 3/4"	1/2"
+96.0	1 1/2"	56 1/2"	1/4"
422+11.5	1 1/2"	56 5/8"	5/8"
+27	1 7/8"	57"	1 1/2" Bent Rail
+42.5	1 3/4"	56 1/2"	1 3/4"
+58.0	1 3/4"	57"	2"
+73.5	1 1/2"	56 3/4"	3 1/8"
+89.0	1 1/2"	56 1/2"	4 1/8"
423+04.5	1 3/4"	56 3/4"	4 1/4"
+20.0	1 7/8"	56 1/2"	4 1/8"
+35.5	2 1/8"	56 3/4"	4 1/16"
+51.0	2 1/2"	56 5/8"	4 1/4"
+66.5	2 1/2"	56 5/8"	4 1/2"
+82.0	2 1/2"	57"	4 3/4"
+97.5	2 1/2"	56 3/4"	4 7/8"
424+13.0	2 1/2"	57 1/8"	5 3/8"
+28.5	2 1/4"	57 3/8"	5 7/8"
+44.0	2"	56 1/2"	5 3/4"
+59.5	2 1/4"	56 3/8"	5 3/4"
+75.0	2 1/8"	56 1/2"	5 3/4"
+90.5	2"	56 3/4"	5 7/8"
425+06.0	2 1/4"	56 3/4"	5 7/8"
+21.5	2"	56 7/8"	5 7/8"
+37.0	2"	56 1/2"	5 7/8"
+52.5	2"	56 1/2"	5 7/8"
+68.0	1 7/8"	56 5/8"	5 5/8"
+83.5	1 5/8"	56 1/8"	5 1/4"
+99.0	1 3/8"	56 3/4"	5 3/8"
426+14.5	1 1/2"	56 3/4"	5 1/2"
+30.0	1 1/2"	57"	5 1/8"
+45.5	1 7/8"	56 1/2"	4 7/8"
+61.0	1 7/8"	56 3/4"	4 1/2"
+76.5	1 7/8"	57"	4 1/4"
+92.0	1 3/4"	57"	4 1/4"
427+07.5	1 7/8"	57"	3 7/8"
+23.0	2 1/4"	56 1/2"	3"
+38.6	2 1/8"	56 1/2"	2 1/8"
+54.0	2 1/4"	56 1/2"	1 3/4"
+69.5	2"	56 3/8"	1 3/8"
+85.0	1 7/8"	56 1/2"	1 3/8"

APPENDIX G

Station	Elevation	Gage	Ordinate
428+00.5	1 3/4"	56 1/2"	1 3/8"
+16.0	1 5/8"	56 3/4"	1 1/4"
+31.5	1 3/4"	57"	3/8"
+47.0	5/8"	56 1/2"	-1/4"
428+78.0	7/8"	56 5/8"	+1/8"
+93.5	3/4"	56 3/4"	
429+09.0	1"	56 5/8"	
+24.5	1 1/4"	56 5/8"	
+40.0	1 1/2"	57 1/2"	
436+82.0	2 1/2"	57 1/2"	6 7/8"
+97.5	2 3/8"	57 1/2"	5 1/8"
437+13.0	2"	57 1/4"	4 3/4"
+28.5	1 7/8"	56 7/8"	4 3/8"
+44.0	1 5/8"	56 7/8"	3 5/8"
+59.5	1 1/8"	57"	2 1/2"
+75.0	1"	57"	1 3/4"
+90.5	5/8"	56 7/8"	1 1/16"
438+06.0	5/8"	56 3/4"	3/4"
+21.5	5/8"	56 3/4"	1/2"
+37.0	3/8"	56 3/4"	1/4"
+52.5	1/4"	57"	1/4"
+68.0	0"	56 5/8"	1/4"
+83.5	0"	56 5/8"	1/4"
+99.0	1/8"	56 3/4"	1/4"
439+14.5	1/4"	56 7/8"	1/4"

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-828/6

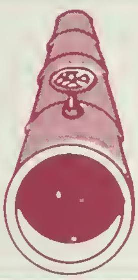


NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

SIDE COLLISION OF NORFOLK AND WESTERN RAILWAY COMPANY'S TRAIN NO. 86 WITH EXTRA 1589 WEST NEAR WELCH, WEST VIRGINIA SEPTEMBER 6, 1980



NTSB-RAR-81-2

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-81-2	2. Government Accession No. PB81-180093	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report--Side Collision of Norfolk and Western Railway Company Train No. 86 with Extra 1589 West, near Welch, West Virginia, September 6, 1980		5. Report Date March 4, 1981
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3192
		11. Contract or Grant No.
		13. Type of Report and Period Covered Railroad Accident Report September 6, 1980
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		14. Sponsoring Agency Code

15. Supplementary Notes
The subject report was distributed to NTSB mailing lists: 8A, 8D and 14A.

16. Abstract

About 8:10 a.m., on September 6, 1980, while operating on the westbound main track, near Welch, West Virginia, eastbound Norfolk and Western Railway Company (N&W) freight train No. 86 collided with the sixth car of N&W Extra 1589 West. The accident occurred while Extra 1589 West was moving from the westbound main track onto an auxiliary center passing track at the east switch of the Farm Interlocking. The engineer, fireman, and front brakeman of train No. 86 were killed. Damage was estimated at $1,446,553.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the head-end crew of train No. 86 to reduce the speed of the train in compliance with the indication of the signal which displayed an approach aspect, which made it impossible for the fireman to stop the train short of the East Farm interlocking home signal when it was seen to be displaying a stop-and-stay aspect.

17. Key Words Freight trains, side collision, hazardous materials, approach signal, stop-and-stay signal, remotely controlled interlocking, alertness control device.		18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*	
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NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: March 4, 1981

SIDE COLLISION OF NORFOLK AND WESTERN RAILWAY COMPANY'S TRAIN NO. 86 WITH EXTRA 1589 WEST NEAR WELCH, WEST VIRGINIA SEPTEMBER 6, 1980

SYNOPSIS

About 8:10 a.m., on September 6, 1980, while operating on the westbound main track, near Welch, West Virginia, eastbound Norfolk and Western Railway Company (N&W) freight train No. 86 collided with the sixth car of N&W Extra 1589 West. The accident occurred while Extra 1589 West was moving from the westbound main track onto an auxiliary center passing track at the east switch of the Farm interlocking. The engineer, the fireman, and the front brakeman of train No. 86 were killed. Damage was estimated at $1,446,553.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the head-end crew of train No. 86 to reduce the speed of the train in compliance with the indication of the signal which displayed an approach aspect, which made it impossible for the fireman to stop the train short of the east Farm interlocking home signal when it was seen to be displaying a stop-and-stay aspect.

INVESTIGATION

The Accident

At 3:05 a.m., e.d.t., on September 6, 1980, eastbound Norfolk and Western (N&W) train No. 86, a high-priority, extra freight train consisting of a 4-unit diesel-electric locomotive, 53 loaded freight cars, 13 empty freight cars, and a caboose, for a trailing tonnage of 4,660, departed Portsmouth, Ohio, en route to Bluefield, West Virginia, a distance of 226 miles. The train had been inspected and the brakes tested, but no defects were found. The engineer and the fireman were in the cab of the lead locomotive unit, the front brakeman was in the cab of the second unit, and the conductor and the rear brakeman were in the caboose.

As the train approached the signal aspect at Williamson, West Virginia, an approach signal was displayed. The fireman, who was a qualified engineer and was operating the train, radioed the yardmaster to determine why the signal aspect was approach. He was advised that a westbound train was preparing to leave the yard but that it was being held until train No. 86 had passed.

After departing Williamson, the train continued to Lindsey, West Virginia, where the train was stopped at a hot-journal detector. At that time, the engineer was operating the train. The suspected car was inspected and when no exception

was made to the journal bearing temperature, the train continued en route. The last radio communication of record was made between the crew and an operator at Lindsey. This communication was recorded by a tape recorder at Bluefield. The enginecrew of Extra 1589 West overheard train No. 86 when the "inspect train" signal at Mohegan was called to each end.

According to the conductor, the fireman was again operating train No. 86 when it moved at 25 mph over a crossover from the eastbound to the westbound main track at Davy, West Virginia. After completing the move over the crossover, train No. 86 accelerated to 38 mph and maintained a speed of 38 mph thereafter. The maximum authorized speed in the area was 40 mph. The train passed over a hot-journal detection device at Davy about 8 a.m., and no faults were indicated. As the locomotive passed the "inspect train" signal associated with the detection device at Davy, the rear-end crew stated that the fireman radioed "Green Eye," indicating that the train was alright. The rear brakeman responded with "Green Eye, Charlie" as the caboose passed the same signal. However, the fireman did not respond to the rear brakeman's message.

At 6:40 a.m., on September 6, 1980, Extra 1589 West, consisting of a 4-unit diesel-electric locomotive, 174 empty coal hopper cars, and a caboose, for a trailing tonnage of 5,220, departed Bluefield, West Virginia, en route to Weller, Virginia. The engineer the and front brakeman were in the cab of the lead locomotive unit, and the conductor and the rear brakeman were in the caboose.

About 7:20 a.m., an eastbound coal train was halted on the eastbound main track in the vicinity of Welch, West Virginia, because the crew of the pusher locomotive assisting the train, had been on duty 12 hours, the maximum time allowed by the Federal hours-of-service regulation. The standing coal train was occupying one of the two main tracks at that location. Because of the delay involved in the crew change, the train dispatcher had directed the train dispatcher to direct the movement of eastbound train No. 86 from the eastbound main track to the westbound main track at Davy. The train dispatcher had planned to divert Extra 1589 West from the westbound main track onto a center passing track at the east end of Farm, a remotely-controlled interlocking. The move would have permitted train No. 86 to continue east on the westbound main track, around the standing coal train, after Extra 1589 West had cleared on the passing track.

Shortly after entering the center passing track at about 8 mph, at the east end of Farm, the engineer of Extra 1589 West observed the headlight of eastbound train No. 86. He stated that train No. 86 was moving at a speed he considered too fast to allow it to stop short of his diverging westward movement. The engineer also said that he did not believe that he had time to use the radio, so he immediately gave hand signals in an attempt to alert the fireman of train No. 86 of the impending danger and hopefully to cause him to set the train's brakes in an emergency application. The enginecrew of Extra 1589 West stated that they observed the operator of train No. 86 rise from his seat at the controls to a semi-erect stance, quickly look ahead, apparently position the automatic brake valve in the emergency position, and then sit down again. Immediately thereafter, they heard the sound of an airbrake emergency application emanating from train No. 86.

The head-end crew on Extra 1589 West testified that they saw only the fireman in the cab of the lead locomotive unit of train No. 86 and that the locomotive of train No. 86 was under power until the emergency brake application was made. The front brakeman of Extra 1589 West moved to the right side of the cab near the engineer and both looked rearward to watch the collision. As the two men watched, they noticed that a stop-and-stay signal aspect was displayed on the Farm interlocking home signal for the eastbound movement.

About 8:10 a.m., while moving at a speed of 38 mph, 180 feet east of the home signal and 1,359 feet into a compound curve to the left, the right front corner of the lead locomotive unit of train No. 86 collided with the sixth car behind the locomotive of Extra 1589 West as it was entering the passing track.

After colliding with Extra 1589 West, the lead unit of train No. 86 collided with a concrete pier supporting a railway trestle over the Tug River Fork and fell into the river between the west bridge abutment and the pier. (See figure 1.) The second unit also collided with the concrete pier and came to rest with the rear end resting on the lead unit and its deformed front end supported by the bridge abutment. (See figure 2.) The third unit came to rest on its side, north of and perpendicular to the track structure; the fourth unit derailed but remained upright. The first six cars of the train derailed. The first car came to rest with the front end resting on the side of the overturned third locomotive unit as did the second car in the train. The second through the fifth cars were derailed in accordian fashion. The sixth car was derailed but remained upright and in line with the track structure. (See figure 2.)

Oil from the damaged locomotive fuel oil tanks spilled into the river and ignited. Flames engulfed the trestle and the locomotive units. The burning fuel oil was carried downstream by the river current and burned foliage along the river bank for several hundred feet.

Of the eight empty coal-hopper cars of Extra 1589 West that were derailed, six were lying on or immediately to the south of the track structure. The two easternmost cars were still on the westbound main track and trestle.

Injuries to Persons

Injuries	Crewmembers Train No. 86	Crewmembers Extra 1589 West	Total
Fatal	3	0	3
Nonfatal	0	0	0
None	2	4	6
Total	5	4	9

Damage

The first three locomotive units of train No. 86 were destroyed, and the fourth locomotive unit was damaged heavily. The first and second derailed cars sustained heavy damage, and the third through the sixth cars were damaged substantially.

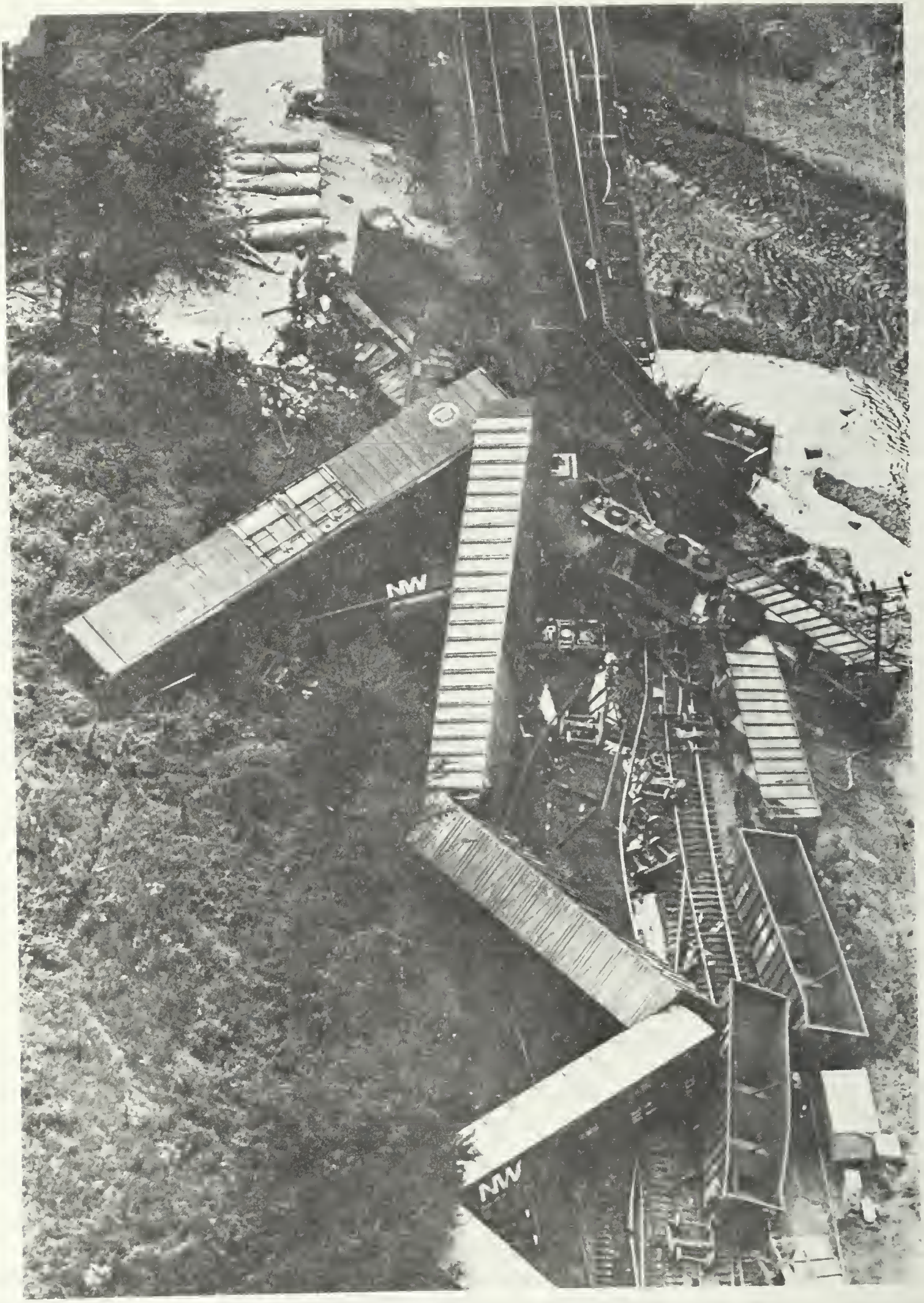


Figure 1.--Side collision of train No. 86 (right) and Extra 1589 West (left).

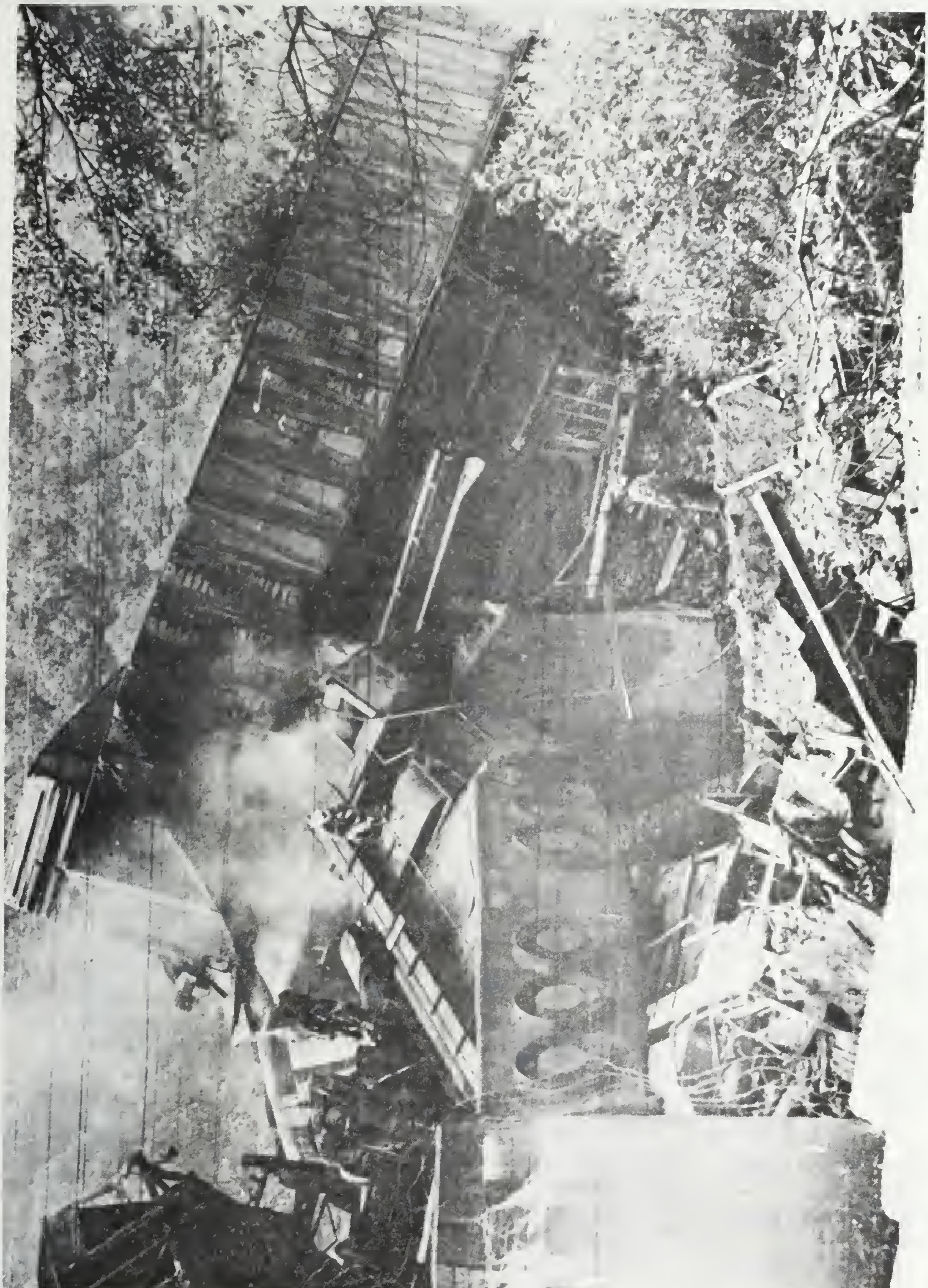


Figure 2.--Wreckage of train No. 86 after it struck Extra 1589 West.

Eight cars of Extra 1589 West were derailed and received substantial damage. Three cars of the train, though not derailed, required a complete change of wheels because they had been subjected to extreme heat from the oil fire.

The trestle over the Tug River Fork was damaged heavily by the fire. The signal equipment and the track received significant damage because of the derailment and subsequent fire.

Locomotive	$ 1,125,900
Equipment	93,500
Trestle	132,000
Signal	44,848
Track	20,305
Clearing wreckage	30,000
Total	$ 1,446,553

Crewmember Information

The crew of train No. 86 consisted of an engineer, a fireman, a conductor, and two brakemen. Each man was qualified without restriction by the N&W standards for his position. The fireman had been off duty since August 29, 1980, before reporting for duty on the day of the accident. All crewmembers were in compliance with the rest requirements of the Federal hours-of-service regulation. They had reported for duty at 2:30 a.m., on September 6, 1980, and had been on duty for 5 hours 45 minutes when the accident occurred. The engine crew reported for duty at a location in Portsmouth where they were not observed by an operating department supervisor or their conductor before the train's departure.

The crew of Extra 1589 West consisted of an engineer, a conductor, and two brakemen. All were qualified without restrictiors by carrier standards for their positions. Each man had been off duty under the applicable regulations before reporting for duty at 2:30 a.m. on the day of the accident. (See appendix B.)

Train Information

Train No. 86 was assembled at Portsmouth, Ohio. The locomotive consisted of one General Electric (GE) Model C-30-7 unit; one Electro-Motive Division (EMD), General Motors Corporation Model SD-45 unit; one EMD GP-38 unit; and one EMD Model GP-35 unit. N&W 8075, the lead unit, was designed with a low profile short hood at the cab end with the controls built at the right side. It was equipped with a speed indicator/recorder, a 26-L type air brake system, a radio, and an electronic crew-alertness control device. The total weight of the locomotive was 1,339,000 pounds.

The 32d car behind the locomotive in train No. 86 was a flatcar loaded with two trailers. Each trailer contained four cylinders of radioactive Uranium Hexaflouride, low specific activity containing 0.7 percent or less of U-235. (Uranium Hexaflouride is not irradiated nor does it require protective shielding.)

The lead locomotive unit of Extra 1589 West was an EMD-Model SD-40, built with dual control stations. It was designed with a low hood profile at the cab end

which was facing rearward at the time of the collision. The length of the train was 9,000 feet. Extra 1589 West was assembled at Norfolk, Virginia, and it was not altered at Bluefield, a crew-change point; therefore, a brake test was not required. However, the engineer used the automatic air brake to stop the train for a signal when it left Bluefield Yard. At the time of the service brake pipe reduction, an undetermined action in the train caused an undesired emergency brake application. The train operated from Bluefield Yard to the accident site without further incident.

Method of Operation

The railroad in the vicinity of the accident follows a water grade route through the Allegheny Mountains, along the Tug River Fork. It is a two-track system extending east and west by timetable direction from the accident site. The north track is designated the westbound main track, and the south track is designated the eastbound main track. The impact occurred in a 4°42' and 5°38' compound curve to the left for train No. 86. The point of impact was at the clearance point in the switch leading from the westbound main track to the auxiliary track at the east end of Farm interlocking. (See figures 3 and 4.)

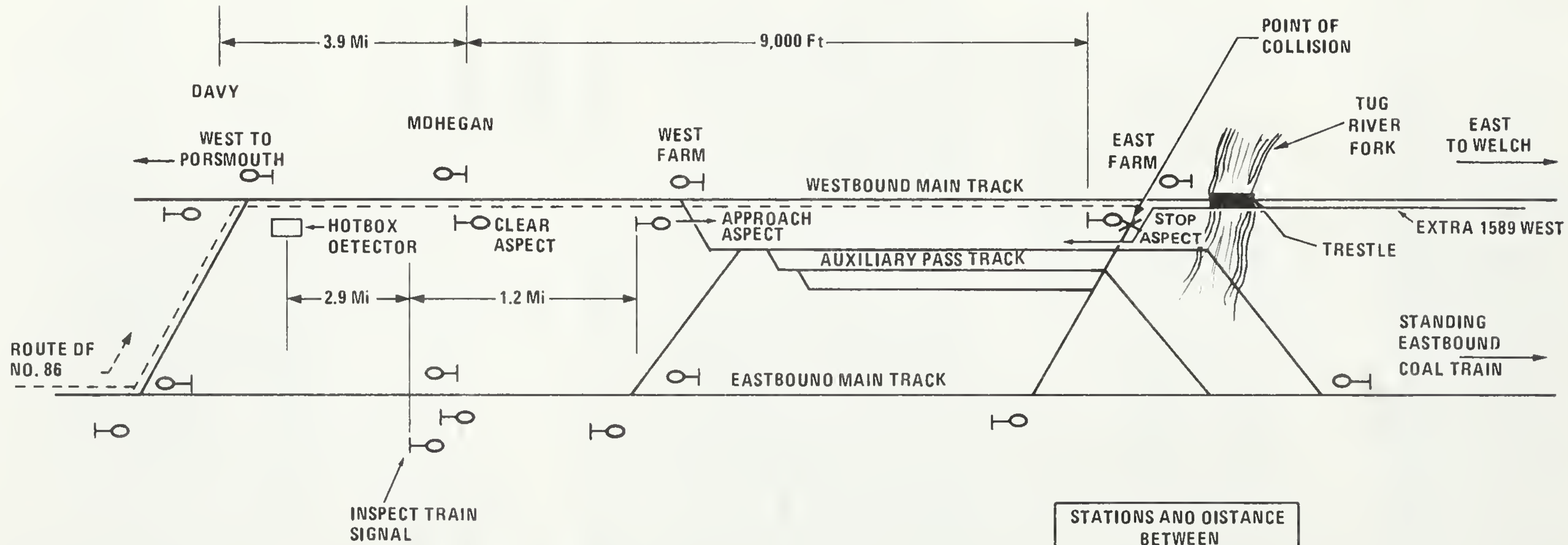
The two main tracks are signaled for train movement in either direction. The distance on the eastbound track between the signal bridge at Mohegan and the point of impact was 9,380 feet. In that distance, the track was a series of short tangent track sections and curves, varying from 0°30' to 6°29'. The power-operated track switches were equipped with dual control, electro-pneumatic switch-and-lock movements. The continuous-lighted, color position-light signals were arranged to display aspects in accordance with the carrier's operating rules. (See appendix C.) When the dispatcher operated the traffic control console to establish the routes of the trains at the east end of Farm, the signal aspects presented to train No. 86 in the direction of travel on the westbound main track would have been:

Location	Name	Rule*	Aspect
Mohegan	clear	281	green lights
west end of Farm	approach	285	yellow lights
east end of Farm	stop-and-stay	292	red lights

*(See appendix C.)

Train operations are governed by timetable, train order, and the signal indications of an automatic-block and traffic-control system (TCS) which is controlled by the train dispatcher at Bluefield. A two-way radio system is used to supplement operations according to applicable operating rules.

Train No. 86 was considered by operating officers to be a priority train as well as being superior by timetable direction. The train dispatcher testified that he thought it unusual that the operator of train No. 86 did not contact him by radio to determine the reason for the "approach" indication at the west end of Farm, but he made no effort to contact the train.



STATIONS ANO OISTANCE BETWEEN
Portsmouth, Ohio
112.2 Miles
Williamson, W. Va.
27.1 Miles
Lindsey, W. Va.
15.1 Miles
Davy, W. Va.
4.9 Miles
Farm, W. Va.
3.5 Miles
Welch, W. Va.

Figure 3.--Plan view of accident area
and route of train No. 86 - not to scale.

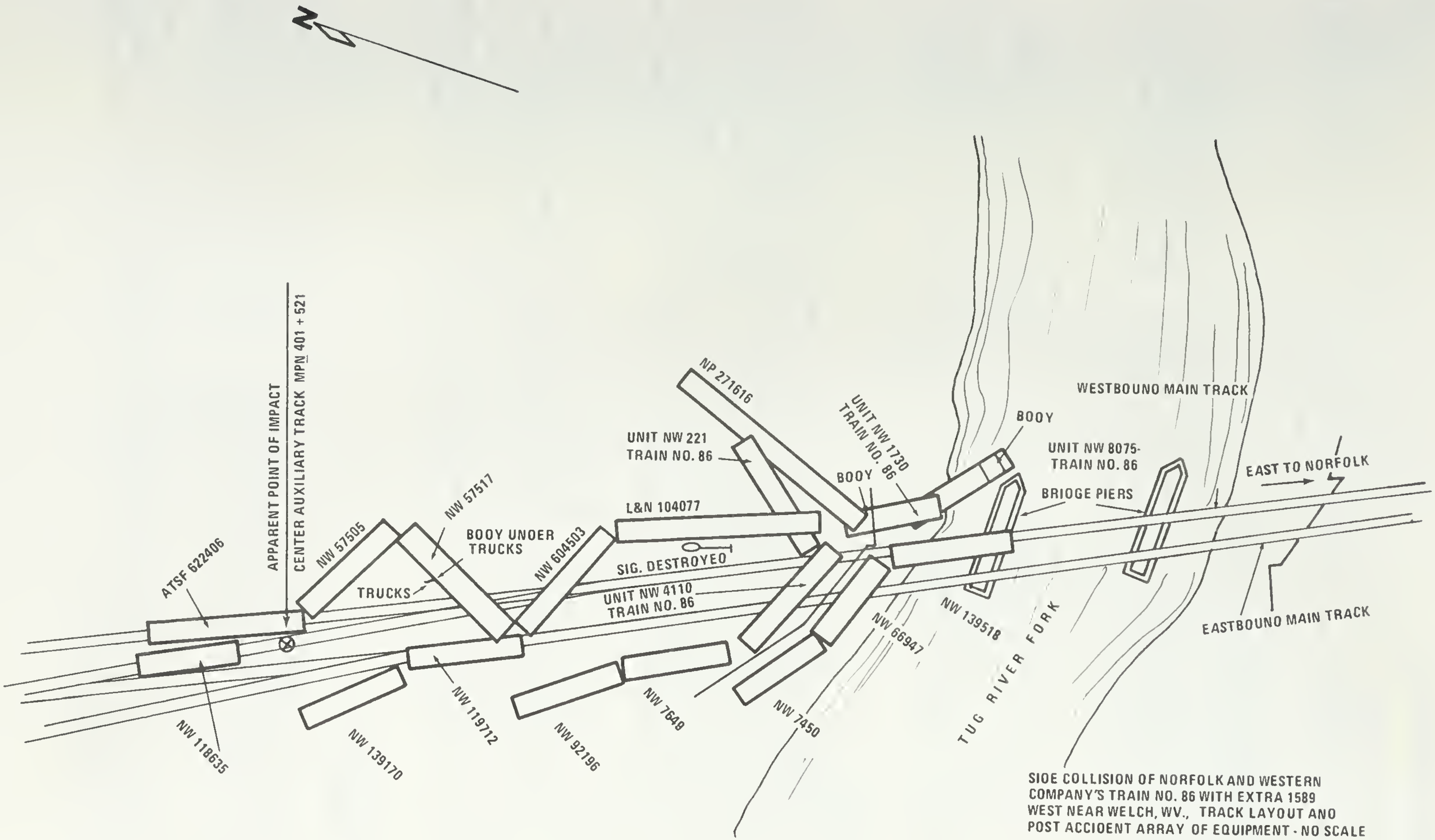


Figure 4.--Track layout and postaccident array of equipment.

Meteorological Information

A Federal Aviation Administration Flight Service Station located in Bluefield (approximately 30 miles east of the accident site) recorded the weather as cloudy, a temperature of 64° F, and visibility at 1/8th mile at 8:00 a.m. Surviving crewmembers indicated that visibility at the accident site was clear.

Medical and Pathological Information

Postmortem and toxicological tests of the fatally injured crewmembers were conducted by the State of West Virginia, Office of the Chief Medical Examiner. The autopsies did not indicate any systemic failure that would have caused impairment. Results of the toxicological tests were:

	Percent of Alcohol	Carbon Monoxide	Drugs
Engineer	Negative	Normal	Negative
Fireman	0.01% 1/	Normal	Negative
Front brakeman	Negative	50% saturated 2/	Negative

Survival Aspect

The engineer's body was found lying under a freight car truck several feet north of the track structure and about 60 feet east of the point of impact. It could not be determined whether he had tried to evacuate the cab before the collision. The fireman's body was found in the crushed cab of the lead locomotive unit. The front brakeman was lodged in the crushed cab of the second locomotive unit. He survived the crash but died as a result of burns and smoke and soot inhalation from the postcrash fire that engulfed the locomotive. The crew of Extra 1589 West was not injured.

The Welch Fire and Rescue Department was notified of the accident at 8:20 a.m., and responded to the scene at 8:26 a.m. The surrounding communities of Davy, Roderfield, Kimball, and Cary, West Virginia, responded immediately to the call for help from the Chief of the Welch Fire Department. After the fire was extinguished, the fire chief used a geiger counter to check radioactive material reported to be on the train. He found the containers to be intact and without leakage.

Tests and Research

The extensive damage sustained by the locomotive units of train No. 86 precluded any testing of the air brake systems. The automatic and independent brake valves from the lead unit were recovered from the river and both portions functioned as designed. The electronic alertness control module and associated

---

1/ The trace of alcohol found in the blood sample could not be traced to recent alcohol consumption. A reading of 0.01% is within the margin of error of analysis.
2/ This is an indication that the front brakeman survived the crash and may have died from the effects of the fire.

whistle were also recovered from the lead unit and, after minor repair of accident damage, they were found to function properly.

Each locomotive unit in train No. 86 was equipped with a speed indicator/recorder. The only legible speed tape was removed from the trailing locomotive unit. The accuracy of the indicator/recorder could not be checked because of damage sustained during the crash. The carrier's maintenance records indicated that the accuracy of the unit was tested on June 27, 1980, at Decatur, Illinois, and at the time, it was found to indicate 3-percent fast. The tape indicated that the train's speed was 38 mph when it collided with the side of Extra 1589 West. (See appendix D.) The tape also indicated that the train had been operated in compliance with the 25-mph speed restriction as it crossed from the eastbound to the westbound main track at Davy.

Postcrash testing of the signal system was performed by N&W personnel and witnessed, in part, by a Signal and Train Control Inspector from the Federal Railroad Administration (FRA). No defects were found in the signal system. During the postcrash inspection, the signal block repeater relay at the west end of Farm indicated that "approach" was the last signal aspect displayed. According to the circuit design, this relay would not have changed position after train No. 86 operated past it into the signal block. (See appendix E.)

Sight distance tests were conducted at the accident site under lighting and weather conditions similar to those at the time of the accident. The same number and type of locomotive units were set up in the same configuration as those of train No. 86. The tests were conducted under static conditions to determine the earliest possible sighting from the various positions on the eastbound locomotive. The tests showed:

Lead Unit Operator's Seat Position South Side	Lead Unit Fireman's Seat Position North Side	Second Unit Side of Cab North	Second Unit Side of Cab South
Available sight distance to "inspect train" signal at Mohegan =			
1,046 ft	1,046 ft	1,051 ft	
Available sight distance to signal at Mohegan =			
1,295 ft	1,295 ft	1,317 ft	926 ft
*Available sight distance to west end of Farm signal =			
414 ft	438 ft	97 ft	405 ft
Available sight distance to east end of Farm signal =			
457 ft	457 ft	448 ft	151 ft
Available sight distance to fouling point, east end of Farm (Westbound and middle track) =			
637 ft	637 ft		

*(See figure 5.)

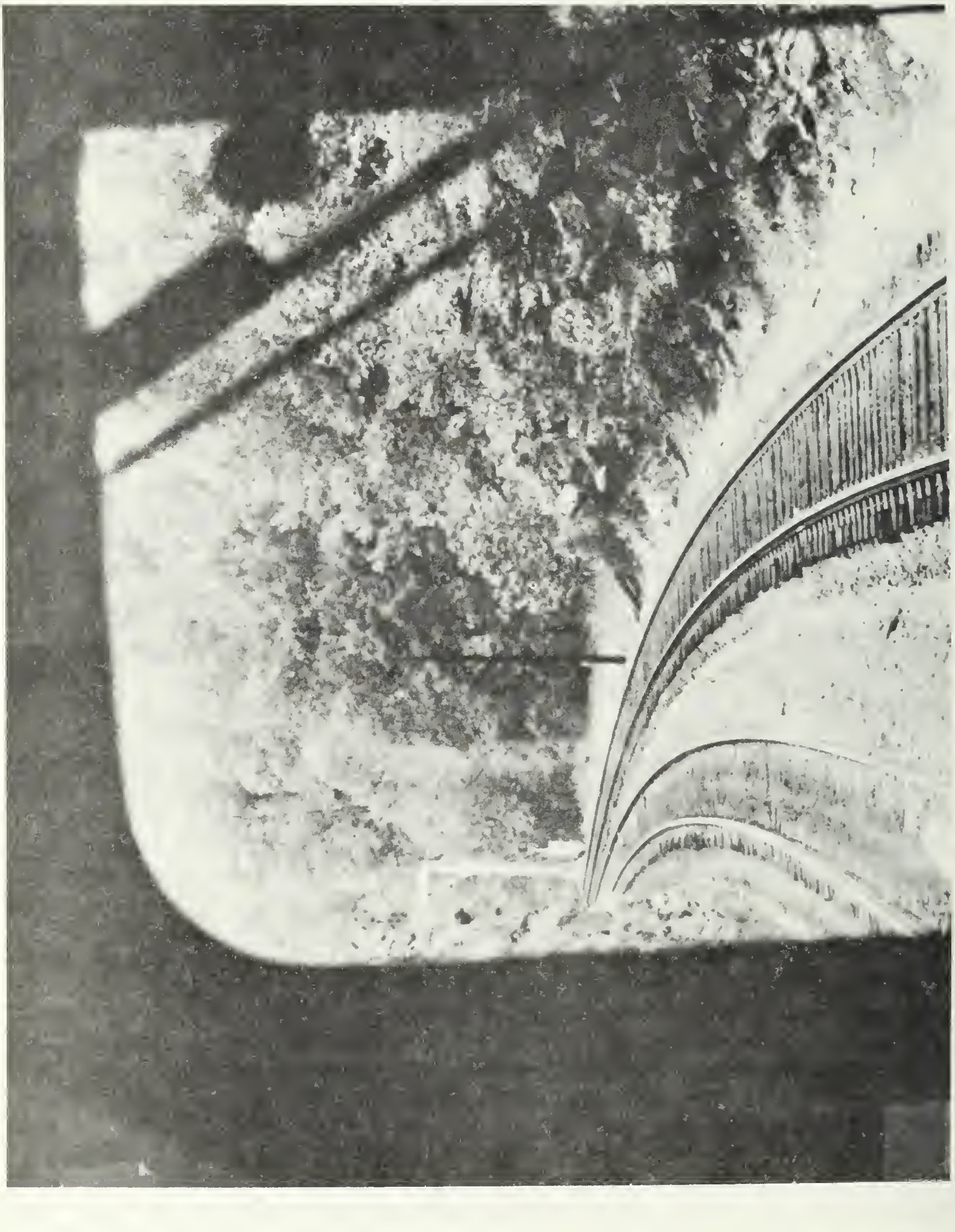


Figure 5.--Eastbound operator's first available sighting of the "approach" signal at the west end of Farm.

Other

Electronic Crew Alertness Device—The electronic crew alertness device is standard equipment for the N&W's locomotive fleet. A flexible stem is attached to the face of the locomotive control stand adjacent to the operator's seat position. The movement of this stem by an operator's action resets the timing cycle of the equipment. The timing circuitry allows 42 seconds to elapse until a light mounted on the control stand is illuminated. The indicator lamp remains illuminated for a period of 10 seconds, at which time a whistle in the cab will begin and continue to sound for 6 seconds. At the end of about 6 seconds, a full service application of the train's air brake system will be initiated. The total time required for a complete cycle is about 60 seconds before a penalty brake application is made. The brake application can be forestalled at any point during the cycle before the initiation of the brake application by the operator's manipulating the flexible stem. Each movement begins a full timing cycle. A fully applied independent brake, or the positioning of the automatic brake in "suppression," will also forestall the alertness device brake application.

ANALYSIS

The Accident

Train No. 86 had been operated in compliance with applicable regulations and operating rules from Portsmouth through the crossover at Davy. The radio communication between the crewmembers on the locomotive and the caboose regarding the "inspect train" signal near Davy, indicated that the operator was alert at that point. However, the fireman, who was operating the train, did not respond to the message from the caboose when it passed the signal. It is reasonable to assume that after crossing from the eastbound to the westbound track at Davy, the fireman believed that his train was being run around a stopped train or one of lower priority which was occupying the eastbound main track. The clear signal indication at Mohegan, the fact that his train was superior by timetable direction and by its lading, and the fact that it was seldom delayed may have caused the fireman to draw a false conclusion about the dispatcher's planned routing of his train. He did not confirm or question the dispatcher about his train being switched from the eastbound to the westbound main track at Davy. Usually, the engineer of a high priority train will question an unusual or unexpected move, especially if it is likely to result in a delay to the train. The radio inquiry from train No. 86 at Williamson concerning the signal indicates that the fireman of train No. 86 operated in this manner. Also, the dispatcher expected the engineer to question the approach aspect at the west end of Farm, and he was surprised that the inquiry did not come.

Despite the river grade route which the railroad follows through the Allegheny mountains, the many curves in the roadway causes some signals to present a very short approach sight distance. The approach sight distance is further reduced in many instances by the high-rock banks or walls where the roadway is built on sidehill cuts.

The 414-foot maximum clear sight distance between the position of the operator's seat of train No. 86 and the approach signal at the west end of Farm

allowed a maximum viewing time of 8.5 seconds at a train speed of 35 mph. (See appendix D.) At this speed, the cab of the lead unit would have passed both the clear signal at Mohegan and the approach signal at the west end of Farm, a distance of 1,149 feet, in about 22 seconds. The transit time for these distances is considerably less than the total 60-second timing cycle of the crew alertness device.

The alertness control device is a good backup for the operator in helping him to maintain an alert posture. However, the approximate 60-second cycle is sufficient time for an engineer to momentarily doze, or become distracted, and not receive an alarm or penalty from the device. Since the alertness control does not respond to the location or aspect of a wayside signal, the engineer could become preoccupied and pass a restrictive signal without seeing it because of a short approach view. He would then be at a disadvantage when the next signal is viewed, again, because of a short approach view to that signal. If he misses an approach aspect and the next signal displays a stop aspect, he may not be able to stop the train before passing the signal even if he is fully alert at the first sighting of the stop aspect. The alertness control device does not ensure that other persons present in the operating cab are alert.

In an area, such as the one where the accident occurred, with short sight distances to signals available because of sharp curves and high embankments, an engineer must remain alert. The approach aspect displayed by the signal at the west end of Farm should have alerted the operator of train No. 86 to take action to reduce the speed of the train to the required medium speed (20 mph) in preparation for a stop at the next signal. Had either the engineer or fireman in the cab of the lead locomotive unit been alert and complying with the requirements of Operating Rule No. 34, the approach indication would have been complied with. The fireman should have seen and properly interpreted the approach signal aspect at the west end of Farm and should have controlled the speed of the train so it could have been stopped at the signal at the east end of Farm. His continued operation of the train without a reduction in its speed is evident from the speed tape obtained during the accident investigation. Since he did not question the dispatcher relative to the restrictive indication or slow his train, he may have been anticipating a nonrestrictive signal indication at the east end of Farm. Therefore, the lack of a radio inquiry or a train speed reduction suggests that the fireman did not perceive the approach indication, that he anticipated a nonrestrictive signal, or that a "false clear" signal indication occurred at the west end of Farm. The state of alertness of the front brakeman, who was in the cab of the second locomotive unit, in terms of his observation of wayside signals as required by Operating Rule No. 34, is questionable.

The position of the block repeater relay indicates that an "approach" aspect was the last aspect displayed by the signal at West Farm. The lack of any evidence of defective conditions with the signal system makes it unlikely that a "false clear" aspect was displayed. The traffic density, the acceptable operating practices, and the physical characteristics of the railroad should preclude an engineer's predicting a clear signal indication following a restrictive one. For one to operate in such a manner is tantamount to suicide and it is not a reasonable assumption. Therefore, the Safety Board must conclude that the enginecrew of train No. 86 was not fully alert as the train passed the approach signal at the west end of Farm.

The Safety Board cannot be certain that the fireman of train No. 86 would have seen an advance approach aspect if one had been presented to the train at Mohegan. However, such a signal would provide an approach view of about 1,300 feet and provide more time for it to be perceived from an approaching train. If the fireman had received an advance approach at Mohegan, he may have stopped the train at the east end of Farm, short of the stop-and-stay signal. Without question, he would have had more opportunity to respond to a restricting signal.

The observations by the head-end crew of Extra 1589 West regarding the movements of the fireman of train No. 86 before the collision exclude the possibility of his being totally incapacitated. This is further supported by the fireman's actions when he apparently became aware of the efforts of the crew of Extra 1589 West to attract his attention. His actions are more nearly described as a man perhaps who may have been preoccupied.

The fact that the locomotive of train No. 86 was observed to be operating under power until the emergency brake was applied further supports that the engine crew of train No. 86 was not fully alert. Postaccident inspections and tests failed to reveal any condition that would have reduced significantly the train's braking capabillity.

Supervision

Since the enginecrew reported for duty at a location where they were not observed by an operating department official, their fitness for duty is unknown. A 226-mile interdivisional run over a railroad with the curvature and short sight distance typical of the area in which the accident occurred places increased demands on the crew to stay alert. Such demands can only be met by crewmembers who are physically and mentally fit. Safety Board investigations of other train collisions have revealed that in such instances, crewmembers have reported for work without a railroad official evaluating their fitness for duty. 2/ The conductor of train No. 86 did not have face-to-face contact with the enginecrew at any time before or during the trip from Portsmouth, Ohio, to the point of collision. Even though the toxicological tests were negative, no one with authority could attest to the physical fitness and alertness of the head-end crewmembers.

Although it allowed him increased freedom of movement from one side of the cab to the other for the purpose of train inspection, the front brakeman's location in the cab of the second unit of the locomotive consist removed him from the surveillance of any on-train authority that could have insured continued alertness throughout the run. His position in the cab of the lead unit would have made him

2/ Railroad Accident Report-"Rear-end Collision of Two Southern Pacific Transportation Company Freight Trains, Indio, California, June 25, 1973 (NTSB-RAR-74-1); Railroad Accident Report-"Rear End Collision of Consolidated Rail Corporation Freight Trains ALPG-2 and APJ-2, near Royersford, Pennsylvania, October 1, 1979" (NTSB-RAR-80-2); and Railroad Accident Report-"Head-on Collision of Baltimore and Ohio Freight Trains Extra 6474 East and Extra 4367 West, Orleans Road, West Virginia, February 12, 1980" (NTSB-RAR-80-9).

more a part of the crew and would have allowed the crew to function more as a team.

CONCLUSIONS

Findings

1. The enginecrew of train No. 86 failed to comply with Operating Rule No. 285 when the train was not slowed prepared to stop at the east end of Farm, and were then unable to comply with Operating Rule No. 292, the stop-and-stay aspect displayed at the east end of Farm.

2. Train No. 86 had been operated in compliance with carrier rules and special instructions for train movement until it passed the approach signal at the west end of Farm.

3. The locomotive electronic alertness control device did not insure that the crew was alert.

4. The fireman, the engineer, and the front brakeman of train No. 86 were not alert enough to perceive and respond to the approach signal at the west end of Farm.

5. The fitness for duty of the enginecrew was not determined by a responsible company official when they reported for duty.

6. Extra 1589 West was being operated in compliance with the carrier's rules and special instructions.

7. Had the signal system been designed so that an advance approach aspect had been displayed at Mohegan when an approach aspect was displayed at the west end of Farm, the accident may have been prevented.

8. The collision caused the derailed locomotive units of train No. 86 to collide with a concrete bridge pier and made the crash and resulting deformation of the lead unit's cab unsurvivable for its occupant.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the head-end crew of train No. 86 to reduce the speed of the train in compliance with the indication of the signal which displayed an approach aspect, which made it impossible for the fireman to stop the train short of the east Farm interlocking home signal when it was seen to be displaying a stop-and-stay aspect.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendation to the Norfolk and Western Railway Company:

> Modify existing signals so that an "advance approach" aspect will be displayed for eastbound trains on both tracks at Mohegan when an "approach" aspect is displayed on either track at the west end of Farm. Where similar conditions exist at other locations, also provide an advance approach aspect. (Class II, Priority Action) (R-81-37)
>
> Establish supervisory procedures at crew-change terminals to insure that all operating department employees coming on duty at any hour of the day are physically fit and capable of complying with all pertinent operating rules. (Class II, Priority Action) (R-81-38)

In addition to this recommendation, the Safety Board reemphasizes the importance of the following recommendation which was made to the Federal Railroad Administration as a result of other collisions: 3/

> Promulgate regulations to require an adequate backup system for mainline freight trains that will insure that a train is controlled as required by the signal system in the event that the engineer fails to do so. (R-76-3)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

s/s JAMES B. KING
Chairman

s/s ELWOOD T. DRIVER
Vice Chairman

s/s FRANCIS H. McADAMS
Member

s/s G.H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Member, did not participate.

March 4, 1981

3/ Railroad Accident Report--"Head-on Collision of Two Penn Central Freight Trains at Herndon, Pennsylvania, March 12, 1972" (NTSB-RAR-73-3); Railroad Accident Report-"Rear End Collision of Two Texas and Pacific Railway Company Freight Trains, Meeker, Louisiana, May 30, 1975" (NTSB-RAR-75-9); and Railroad Accident Report-"Rear End Collision of Southern Pacific Transportation Company Freight Trains 02-HOLAT-21 and 01-BSMFK-20 Thousand Palms, California July 24, 1979" (NTSB-RAR-80-1).

APPENDIXES

APPENDIX A

INVESTIGATION

The National Transportation Safety Board was notified of the accident about 10:30 a.m., on September 6, 1980. Three investigators from the Atlanta field office of the Safety Board were dispatched to the scene. A public hearing was not held, and depositions were not taken.

APPENDIX B

NORFOLK AND WESTERN RAILWAY COMPANY CREWMEMBER INFORMATION

Train No. 86

Engineer John Wallace Reed, Jr.

Engineer Reed, 59, has been employed by the N&W in engine service for 34 years. He began as a fireman and was promoted to locomotive engineer during January 1953. His last biennial physical examination* was on July 30, 1979. His personnel records indicated that he had been disciplined for his responsibility in a train collision in 1948, for passing a stop-and-stay signal in 1961, for his responsibility in a collision on a yard track in 1966, and for his responsibility in a derailment in 1974. He passed his last operating rules examination in September 1979.

Fireman Charles A. Basore

Fireman Basore, 40, had been employed by the N&W in engine service for 15 years. He began his railroad service as a fireman and was promoted to locomotive engineer on March 13, 1969. He had successfully passed an operating rules examination on February 15, 1980. He was examined during a carrier-sponsored eye examination program on August 30, 1979, and was not restricted. His personnel record indicates that he had not been disciplined since he began employment with the N&W.

Front Brakeman Marvin Cheek

Front Brakeman Cheek, 61, had been employed by the N&W for 37 years. With the exception of 8 months, all railroad experience had been in train service. He passed his last operating rules examination on February 5, 1980. His most recent biennial physical examination was May 7, 1979, and he was not restricted. His personnel record indicates that he had not been disciplined since he began employment with the N&W.

Conductor Jeffrey M. Preston

Conductor Preston, 27, had been employed by the N&W in train service for 9 years and was promoted to conductor in July 1974. He was last successfully examined on operating rules on September 26, 1979. He had been off duty for 12 hours 40 minutes before reporting for duty on the day of the accident.

Flagman Jesse Parsely

Flagman Parsely, 60, had been employed by the N&W for 34 years in train service. He was a promoted conductor but had relinquished his conductor's

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* N&W requires employee over 50 years of age to submit to a biennial physical examination.

seniority to hold the interdivisional run as a regular brakeman. He had been off duty for 38 hours 38 minutes before reporting for duty on the day of the accident.

Extra 1589 West

Engineer Kenneth G. Croy

Engineer Croy, 33, has been employed by the N&W for 9 1/2 years and was promoted to engineer on April 11, 1973. He was last examined on operating rules during the spring of 1980.

Front Brakeman Anthony A. Dillard

Front Brakeman Dillard, 25, has been employed by the N&W in train service for 4 1/2 years.

Conductor Ralph D. Ryburn

Conductor Ryburn, 46, has been employed by the N&W in train service for 24 years and was promoted to conductor during January 1964.

Flagman Joseph P. Borich

Flagman Borich, 27, has been employed by the N&W in train service for 2 years 10 months.

APPENDIX C

EXCERPTS FROM N&W OPERATING RULE BOOK AND CURRENT TIMETABLE AND DIAGRAMS OF SIGNAL ASPECTS

The following have been excerpted from N&W Operating Rule Book and Current Timetable:

N&W Timetable No. 7, Special Instructions,

General

No. 6 Eastward or northward trains are superior to trains of the same class in the opposite direction.

Rule 34, Book of Rules, is changed to read as follows:

Employees located in the operating compartment of an engine must communicate to each other in an audible and clear manner the name or aspect of each signal affecting movement of their train or engine, as soon as the signal is clearly visible or audible. It is the responsibility of the engine man to have employees comply with these requirements, including himself.

It is the engineman's responsibility to have each employee located in the operating compartment maintain a vigilant lookout for signals and conditions along track which affect the movement of the train or engine.

Crewmembers not located in the operating compartment of the engine, who are in a position to see or hear signals affecting the movement of their train or engine, must do so, and if other crewmembers are present, must communicate to them, in an audible and clear manner, the name or aspect of each signal.

If a crewmember becomes aware that the engineman has become incapacitated or should the engineman fail to operate or control the train or engine in accordance with the signal indication or other conditions requiring speed to be reduced, other crewmembers must communicate with him at once, and if he fails to properly control the speed of the train or engine, they must take action necessary to ensure the safety of the train or engine, including operating the emergency valve.

Signals:
N&W Operating Rule 281
Name - Clear

Indication - Proceed at prescribed speed.

N&W Operating Rule 285
Name - Approach

Indication - Proceed preparing to stop at next signal. If exceeding

medium speed immediately take action to reduce to that speed.*

*Definition - One-half the maximum authorized speed, but not exceeding 30 miles per hour.

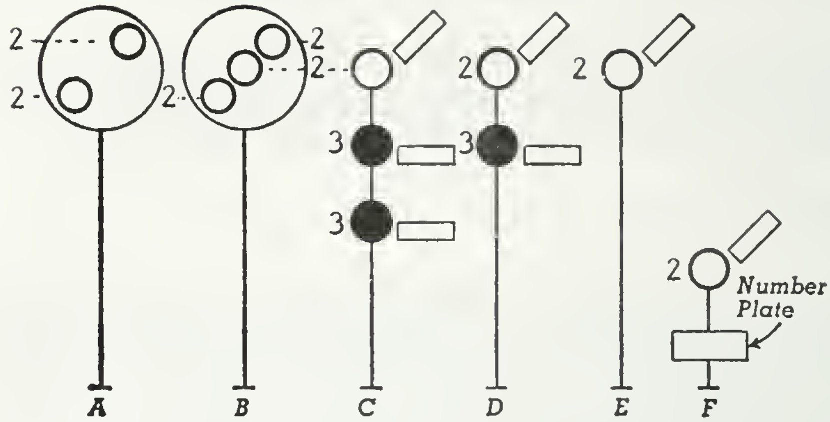
N&W Operating Rule 292
Name - Stop and Stay Indication - Stop and Stay.
N&W Operating Rule 582 - Enginemen

Enginemen must keep a vigilant lookout in the direction of movement for signals and obstructions and look back at frequent intervals for any defects in their train.

N&W Operating Rule 340

When a signal indicates stop, stop must be made before reaching the signal, except that trains approaching meeting or passing points and finding a signal displaying "stop and proceed" indication may proceed at restricted speed without stopping for such signal when the signal is located at or near the pull-in switch, provided the pull-in switch is open and proceed signal is given by person handling the switch.

Rule 285

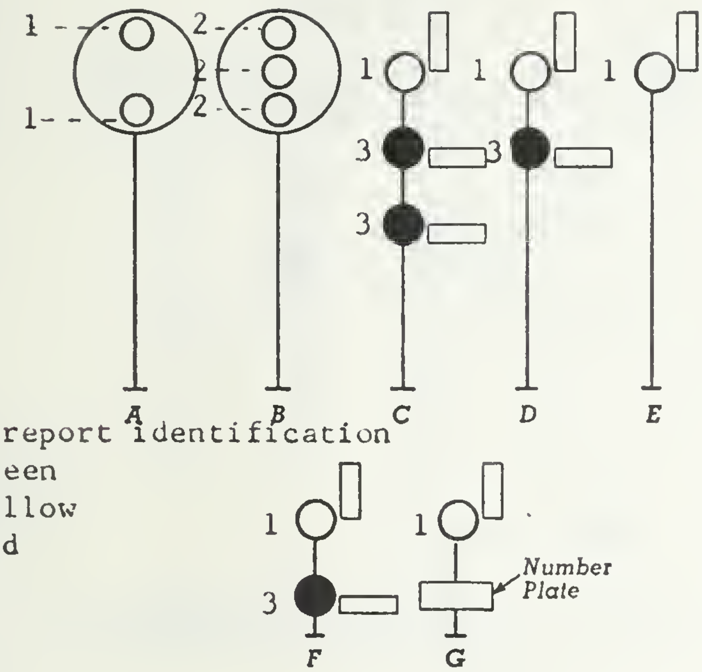


Indication—Proceed preparing to stop at next signal. If exceeding medium speed immediately take action to reduce to that speed.

Name—Approach.

For report identification
1=Green
2=Yellow
3=Red

Rule 281

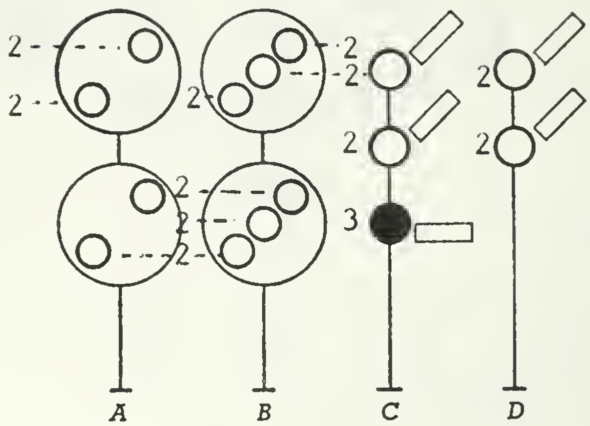


For report identification
1=Green
2=Yellow
3=Red

Indication—Proceed at prescribed speed.

Name—Clear.

Rule 282-A

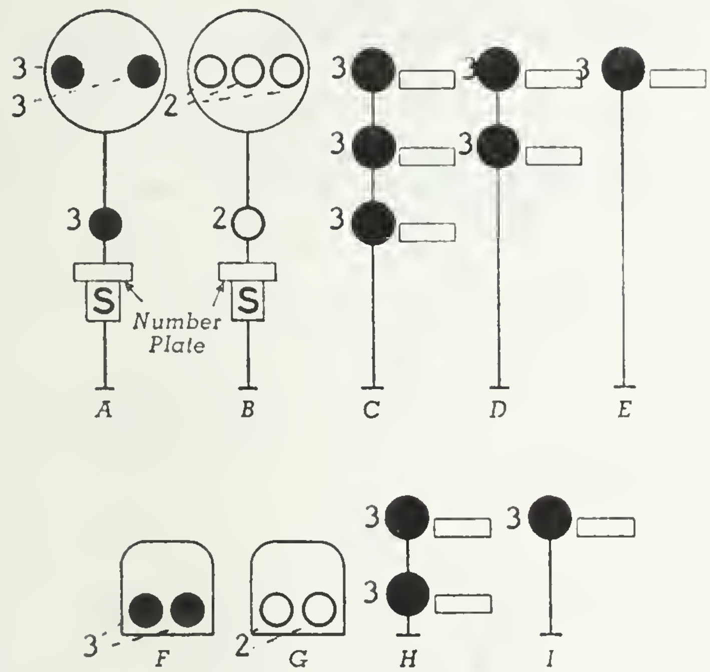


Indication—Proceed preparing to stop at second signal.

Name—Advance approach.

For report identification
1=Green
2=Yellow
3=Red

Rule 292



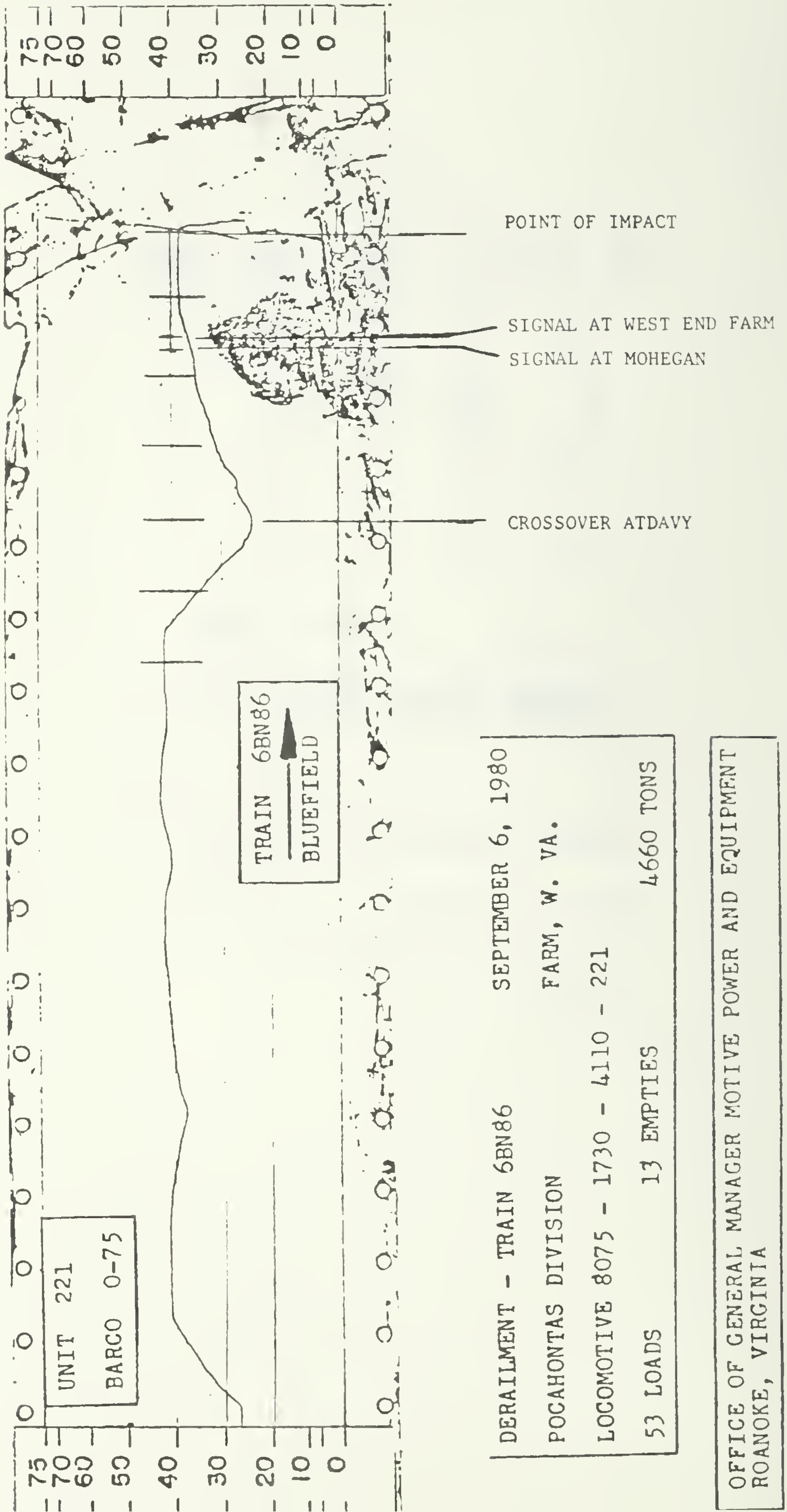
Indication--Stop and stay.

Name--Stop and stay.

For report identification
1=Green
2=Yellow
3=Red

APPENDIX D

SPEED TAPE FROM TRAIN NO. 86



APPENDIX E

REPORT OF FEDERAL RAILROAD ADMINISTRATION'S SIGNAL INSPECTOR

SUMMARY OF SIGNAL TESTS FOLLOWING ACCIDENT AT FARM, W. VA.

Saturday, September 1980

Tests conducted by Norfolk and Western personnel were under the direction of or supervised by the assistant chief engineer of signals and communications and the Pocahontas regional engineer of signals and communications who was assisted by various system personnel as well as division personnel. I participated or witnessed the tests as indicated below.

Saturday Afternoon, September 6, 1980

1. Insulation resistance test and proving of LA52BP control circuit between east end Farm and west end Farm by railroad personnel.

Saturday Night, September 6, 1980, and Sunday Morning, September 7, 1980

**2. Insulation resistance tests of all cable conductors between east end Farm and west end Farm. (No exceptions taken)

3. Testing of all relays involved in circuitry for control of signal 52L west end Farm and 48L east end Farm. (No exceptions taken)

*4. Track circuits east end Farm to west end Farm proved and tested for shunting sensitivity. (No exceptions taken)

*5. East end Farm time locking. (No exceptions taken)

*6. East end Farm route locking. (No exceptions taken)

*7. Tests for grounds east end Farm. (No exceptions taken)

8. Tests for grounds west end Farm. (No exceptions taken)

Tests 7 and 8 further substantitated Test 2.

Sunday Afternoon, September 7, 1980

*9. Operational tests simulating actual train movements were made between west end Farm and Welch including east end Farm on No. 1 track. These tests were made by simulating crossover 47 at the east end Farm as the main line switch and turnout were destroyed by the accident. The tests were run from the equipment house at the east end of Farm using telephones or radio forcommunicating with other locations. A speaker phone was used at this location so incoming as well as outgoing conversations could be monitored by everyone at this location. No exceptions were taken of the operations of the signal system in this vicinity.

*FRA inspector participated or witnessed entirely.
** FRA inspector participated or witnessed portions of tests.

APPENDIX E

Tuesday, September 9, 1980

*10. Examination records of tests of signal equipment in this vicinity at Bluefield office.

Thursday Morning, September 11, 1980

***11. Sight test of preview of signal 52L west end Farm and 48L east end farm. (No exceptions taken)

* FRA Inspection participated or witnessed entirely
*** FRA Inspector and NTSB Investigator participated or witnessed entirely.

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-828/9

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

REAR-END COLLISION OF UNION PACIFIC RAILROAD COMPANY FREIGHT TRAINS NEAR HERMOSA, WYOMING OCTOBER 16, 1980

NTSB-RAR-81-3

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-81-3	2. Government Accession No. PB81-195448	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report--Rear-End Collision of Union Pacific Railroad Company Freight Trains Near Hermosa, Wyoming, October 16, 1980		5. Report Date April 7, 1981 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3123A 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Railroad Accident Report October 16, 1980 14. Sponsoring Agency Code

15. Supplementary Notes
The subject report was distributed to NTSB mailing lists: 8A, 8D and 14A.

16. Abstract About 3:06 p.m., on October 16, 1980, Union Pacific Railroad Company (UP) freight train Extra 3749 West (NPH-16) struck the rear of UP grain train Extra 3557 West (SGTLB-635) while it was standing about 100 feet west of intermediate signal No. 5517 near Hermosa, Wyoming. Two train crewmembers were killed and two crewmembers were injured. The 3 locomotive units of NPH-16 and 16 cars, including the caboose, of SGTLB-635 were derailed. Total damage was estimated to be $993,000.

The National Transportation Safety Board determines that the probable cause of this accident was the inadequacy of Union Pacific rules in explaining train handling and braking procedures, along with the engineer's lack of comprehension of those rules and his inadequate handling of the train's brakes which resulted in his failure to bring the train to a stop as required before reaching signal No. 5517. Further, there was a lack of necessary communication among train crewmembers and with the dispatcher.

17. Key Words rear-end collision; stopping; human failure; employee casualty; freight train; caboose;locomotive; signal compliance; crew training; safety devices		18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*	
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NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: April 7, 1981

REAR-END COLLISION OF UNION PACIFIC RAILROAD COMPANY FREIGHT TRAINS NEAR HERMOSA, WYOMING OCTOBER 16, 1980

SYNOPSIS

About 3:06 p.m., on October 16, 1980, Union Pacific Railroad Company (UP) freight train Extra 3749 West (NPH-16) struck the rear of UP grain train Extra 3557 West (SGTLB-635) while it was standing about 100 feet west of intermediate signal No. 5517 near Hermosa, Wyoming. Two train crewmembers were killed and two crewmembers were injured. The 3 locomotive units of NPH-16 and 16 cars, including the caboose, of SGTLB-635 were derailed. Total damage was estimated to be $993,000.

The National Transportation Safety Board determines that the probable cause of the accident was the inadequacy of Union Pacific rules in explaining train handling and braking procedures, along with the engineer's lack of comprehension of those rules and his inadequate handling of the train's brakes, which resulted in his failure to bring the train to a stop as required before reaching signal No. 5517. Further, there was a lack of necessary communication among train crewmembers and with the dispatcher.

INVESTIGATION

The Accident

On October 16, 1980, Union Pacific Railroad Company (UP) westbound grain train Extra 3557 West (SGTLB-635), consisting of 3 locomotive units, 76 loaded cars, and a caboose, departed Cheyenne, Wyoming, at 10 a.m. for Rawlins, Wyoming. Between Cheyenne and Dale Junction, Wyoming, SGTLB-635 operated over main track No. 3. At Dale Junction, SGTLB-635 was routed by the dispatcher onto the No. 2 track as it continued to East Hermosa, Wyoming. (See figure 1.)

According to the engineer and head brakeman, who were in the lead locomotive unit, the home signals at East Hermosa and West Hermosa, Wyoming, continuously displayed clear 1/ and advance approach 2/ aspects, respectively,

---

1/ "Clear" requires that a train proceed at authorized speed.
2/ "Advance approach" requires that train speed not exceed 40 mph when passing the next signal.

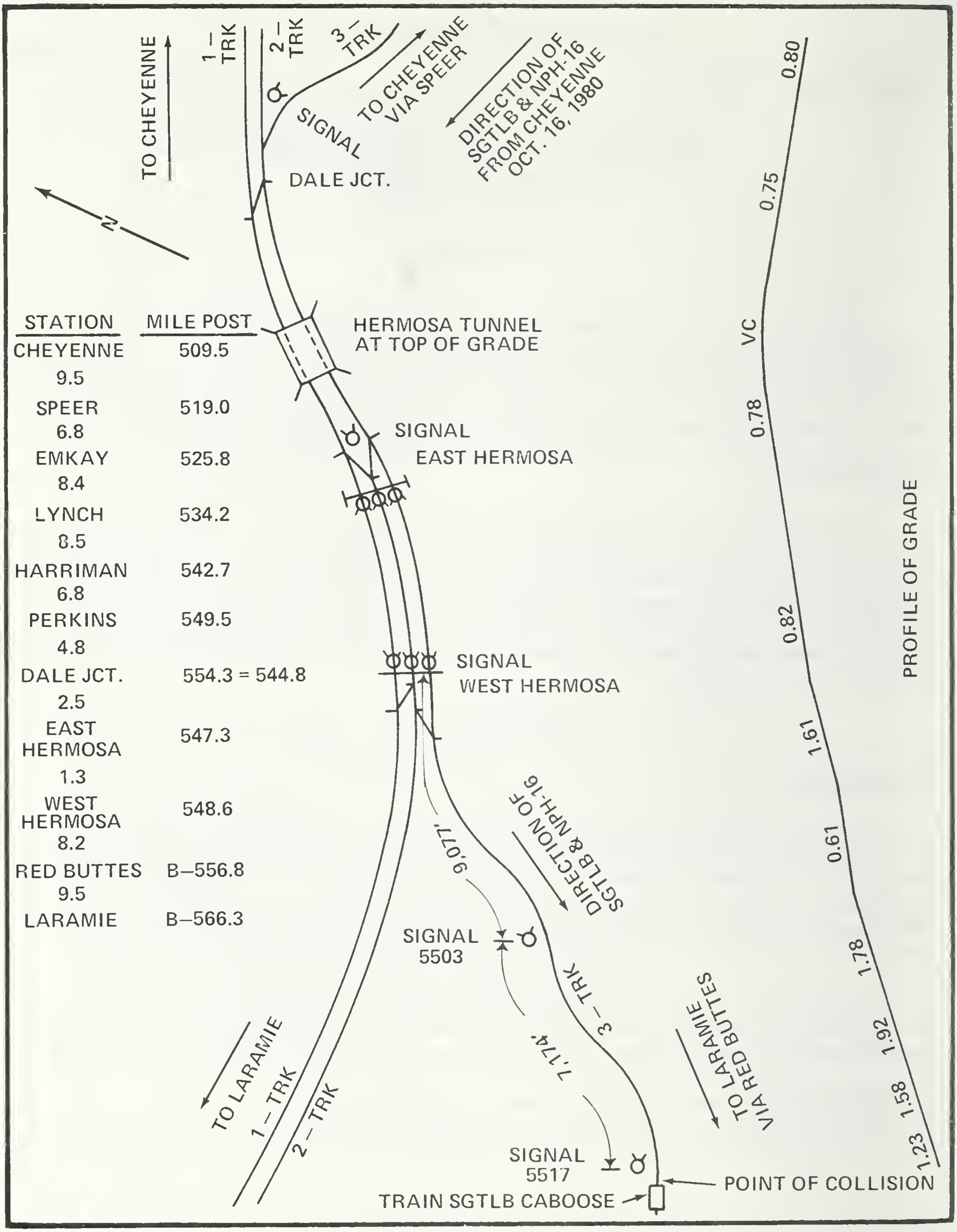

Figure 1.--Sketch of Hermosa area track alignment and grade.

as SGTLB-635 approached and until the lead locomotive unit passed each signal. These aspects were properly repeated by the locomotive cab signals. About 1:32 p.m., the train had been routed back onto track No. 3 at East Hermosa, and shortly after the engineer had acknowledged the more restrictive cab signal at West Hermosa, the train had an uncalled for emergency application of the brakes. The conductor, who was in the caboose with the rear brakeman, immediately radioed the engineer to determine why the train had stopped. The engineer said it may have been caused by his application of the brakes entering a descending grade. The rear brakeman then radioed the dispatcher in Cheyenne to notify him of the emergency brake application and to determine if any trains were approaching on the adjacent tracks. The dispatcher acknowledged the radio message by advising that no trains were approaching. Meanwhile, the conductor had begun to walk toward the locomotive to inspect the train, but when he heard the air begin to recharge the brakepipe, he returned to the caboose.

About 1:45 p.m., the engineer began operating the train down a 1.8-percent descending grade toward Red Buttes, Wyoming. The engineer and head brakeman said that when the train approached the next two intermediate signals, Nos. 5503 and 5517, the signals continuously indicated approach 3/ and stop-and-proceed 4/ aspects, respectively. These aspects were properly repeated by the locomotive cab signals and acknowledged by the engineer. As the train approached the stop-and-proceed signal, the engineer could see several miles in the distance, and he noticed what appeared to be other trains stopped on the track ahead near Red Buttes. After stopping and passing signal No. 5517, the engineer operated the train under 20 mph until he stopped about 500 feet from the caboose of a train ahead. This stop, which occurred about 2 p.m., left the caboose of SGTLB-635 about 100 feet west of, and inside the block protected by, signal No. 5517. The conductor said he did not send the rear brakeman eastward to protect the rear of the train because protection is not required in signalized territory and the rear-facing red signal light on the roof of the caboose was illuminated.

The conductor remained in the cupola of the caboose during the following hour while the rear brakeman remained below at the conductor's desk. About 3:06 p.m., the conductor said that he heard a voice on his radio say "look out in the caboose." When he stood up to look to the east, the caboose was struck by the lead locomotive unit of westbound UP freight train Extra 3749 West (NPH-16). The impact of the collision propelled the conductor from the caboose. The rear brakeman, still seated at the conductor's table, was killed in the collision.

NPH-16 had arrived at Cheyenne about 10:25 a.m. from North Platte, Nebraska, where it had been given a 500-mile inspection and brake test. The arriving crewmembers told the relieving crewmembers that they had experienced no problems with the train en route. No brake test was required before departing Cheyenne, and the outgoing engineer took no exceptions to the condition of the train. NPH-16 departed Cheyenne westbound about 10:35 a.m. for Rawlins with a

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3/ "Approach" requires that a train's speed be immediately reduced to 30 mph after passing the signal and that the train stop short of the next signal.

4/ "Stop and proceed" requires that a train stop before any part of the train or engine passes the signal and then proceed at restricted speed through the entire block stopping before any train or obstruction.

maximum authorized speed of 50 mph shown on its clearance form. The train consisted of 3 locomotive units, 68 loaded cars, and a caboose. The engineer and head brakeman were in the lead locomotive unit, which was operated by the engineer from the right side, and the conductor and rear brakeman were in the caboose. At West Cheyenne the cab signals operated as intended when the locomotive passed over the test circuits.

Between Cheyenne and Dale Junction, NPH-16 operated over the No. 3 main track. En route the train was stopped three times to comply with signals displaying stop aspects. The signals which preceded the stop signals displayed advance approach and approach aspects, respectively. The engineer said these signal aspects were properly repeated by the locomotive cab signals. When approaching Dale Junction about 1:30 p.m., NPH-16 was stopped by an uncalled for emergency application of the brakes. The engineer radioed the conductor that when applying the brakes to stop for the stop signal at Dale Junction, there may have been a penalty application from the cab signal acknowledging device. The crewmembers did not notify the dispatcher about this emergency application because the air began to quickly recharge the brakepipe.

Departing Dale Junction, NPH-16 was routed on track No. 2 to East Hermosa and about 2 p.m. was stopped just east of East Hermosa because the home signal displayed a stop aspect. At 2:19 p.m., the dispatcher activated the routing for NPH-16 on track No. 3 to Red Buttes and Laramie. The home signal changed immediately to a clear aspect, indicating that the train could proceed. At 2:45 p.m., the dispatcher attempted to radio NPH-16 crewmembers because his train graph indicated that NPH-16 had not yet moved; the crewmembers said later that they did not hear the radio message. At 2:58 p.m., the train graph indicated that NPH-16 had begun to move, so the dispatcher did not attempt to contact the engineer to determine why the train had not moved earlier. The engineer later told investigators that the head brakeman was not feeling well and that he had gone to the second locomotive unit to use the lavatory. He said that he waited until the head brakeman returned before moving the train. The engineer said that he did not attempt to notify the dispatcher of the head brakeman's illness and that he was never contacted by the conductor about the delay at East Hermosa.

The engineer said that after departing East Hermosa he made a minimal test application of the dynamic brake 5/ near the road crossing at West Hermosa as required before reaching the 1.8-percent descending grade. He said the signal at West Hermosa displayed a clear aspect and that the cab signal corresponded. He recalled his speed to be about 25 mph and that the visibility was good. According to the engineer, the next signal, No. 5503, displayed a clear aspect and that after passing the signal he made a minimum application of the airbrakes to control the speed of the train on the descending grade. The engineer said that when the next signal, No. 5517, came into view about 1,000 feet ahead, it was displaying a clear aspect, and that he also immediately saw the red marker light of a caboose just beyond the signal. He said that while he applied the brakes in emergency, he may have quickly radioed a warning to the crewmembers to get off the caboose. He

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5/ Dynamic braking is obtained only on the locomotive units when the electric traction motors are changed to generators which cause a retardation in the speed of the locomotive.

recalled that his train speed was about 35 mph when the lead locomotive unit of NPH-16 collided with the caboose of SGTLB-635. The head brakeman of NPH-16 was killed and the engineer was critically injured. The engineer did not recall the actions of the head brakeman during the trip from East Hermosa or what occurred after the collision.

Shortly after the accident, the conductor of SGTLB-635 climbed into the second unit of NPH-16 and radioed the enginer of SGTLB-635 to find out if an ambulance was on the way. The engineer, however, was not immediately aware that an accident had occurred until he heard this request for an ambulance. He recalled that his locomotive had moved forward a few feet several minutes before the radio message and that the train's airbrakes had applied in emergency. However, he was not overly concerned because of the train's earlier uncalled-for emergency brake application at West Hermosa. While he was evaluating the train's condition, the engineer heard the message from the conductor. He quickly radioed the operator at Laramie and the dispatcher about the collision. The time was about 3:10 p.m.

UP supervisors immediately notified local emergency rescue personnel while uninjured crewmembers from SGTLB-635 and NPH-16 went to the accident site to aid the injured. Ambulances and a helicopter were quickly dispatched to the scene, and the UP sent a vehicle that could operate in snow from Laramie with two company supervisors. The vehicle was used in assisting the emergency personnel to carry the injured to the helicopter and ambulances which had to remain some distance from the scene because of snow conditions.

Injuries to Persons

	SGTLB-635 Crewmembers	NPH-16 Crewmembers	Total
Fatal	1	1	2
Nonfatal	1	1	2
None	2	2	4
Total	4	4	8

Damage

The caboose and three rear cars of SGTLB-635 were derailed. Most of the collision force was absorbed by the caboose, which was demolished. Only a portion of the cupola and the windows on its right side were still intact. The two rear cars of grain were heavily damaged when they were derailed and overturned, one to the south and one to the north of the track. The third rear car of grain was upright in the track with its rear truck derailed.

The 3 locomotive units and lead 13 cars of NPH-16 were derailed. The lead unit left the track to the south and overturned onto its left side, stopping about 155 feet west of signal No. 5517. The lead unit sustained moderate damage to its forward hood and operating compartment. The two following units jackknifed and became crosswise with the track. The second unit was heavily damaged when struck by the following unit and derailed cars. The third unit sustained only minor

damage. Ten of the 13 derailed cars were demolished. About 360 feet of the track was destroyed. Westbound signal No. 5517 and eastbound signal No. 5318 were knocked down and were lying on the north and south sides of the track, respectively. The signal relay case was damaged and lying on its back on the north side of the track.

Damage was estimated to be as follows:

Train equipment	$598,000
Train lading	280,000
Track	75,000
Signal and communications	5,000
Clearing of wreckage	35,000
Total	$993,000

Crewmember Information

Each of the trains involved in the accident had an engineer, conductor, and two brakemen. All were qualified under UP operating rules.

The crewmembers of NPH-16 (see appendix B) reported for duty at 10:15 a.m. on October 16, 1980, and had been on duty about 4 hours 50 minutes when the accident occurred. The engineer and conductor were regularly assigned to the Cheyenne-Rawlins through-freight pool. The head brakeman and rear brakeman were extra employees working temporary vacancies from the extra list. The engineer had 30 years service as a fireman and engineer and had been qualified as an engineer on the Cheyenne-Rawlins territory in 1969. Prior to reporting to work on October 16, 1980, the engineer had been off duty for 22 hours. He stated that on October 15 1980, he had spent a normal day at home and that on October 16 1980, he awoke about 7 a.m. after a full night's sleep. Immediately after the accident, the engineer's attending physician at the Laramie hospital reported that he found no evidence of alcohol in his examination. The engineer of NPH-16 was required to wear glasses with corrective lenses while on duty. He stated that he was wearing his glasses at the time of the accident.

The head brakeman had 2 years of service as a brakeman and had last worked on October 15, 1980. A postmortem toxicological and drug screen examination was negative for alcohol and drugs.

The conductor had been off duty for more than 48 hours and the rear brakeman had been off duty for 18 hours 15 minutes before reporting to work. The conductor said he noticed nothing unusual about the condition or behavior of the engineer or head brakeman at the time they reported.

The crewmembers of SGTLB-635 had reported for duty at 9:30 a.m., October 16, 1980, and had been on duty about 5 hours 40 minutes when the accident occurred. All crewmembers had been off duty more than 24 hours before reporting for duty.

Train Information

NPH-16 originated in North Platte, and the original makeup of the train had never been altered. At the time of the accident, the train consisted of 3 General Motors Model SD40-2, diesel-electric locomotive units, Nos. 3749, 3363, and 3521; 68 cars of mixed freight; and a caboose. The train was about 4,000 feet long and had about 5,450 trailing tons. It was authorized to operate at a maximum speed of 50 mph except in areas with speed restrictions and on descending grades according to special instructions. The lead locomotive unit, No. 3749, had its short low hood forward and was equipped with functioning headlights, speed indicator, and an operable cassette-type event recorder capable of recording elapsed time, speed and distance, amperage, direction of movement, throttle position, airbrake applications, dynamic braking, and independent braking. The unit was also equipped with an operable UP radio, overspeed control, floor-mounted deadman pedal, and cab signals with acknowledging lever and warning device. If a more restrictive cab signal was not acknowledged, an automatic full service application of the airbrakes would occur. The warning device was mounted on the forward wall adjacent to the cab signal indicator near the center of the cab. The cab signals could be seen from both the engineer and the brakeman positions. The brakeman position was provided with an emergency airbrake valve. The caboose had bay windows in lieu of a cupola. Both lead unit and caboose had functioning permanent radios using the UP frequency.

SGTLB-635 consisted of 3 General Motors Model SD40-2 locomotive units, 76 loaded hopper cars of grain, and a caboose. The lead unit was equipped with functioning cab signals, speed indicator, speed recorder, floor-mounted deadman pedal, and an operable UP radio. The train had about 9,400 trailing tons, was about 4,280 feet long, and was authorized to operate at a maximum speed of 50 mph. The caboose was a cupola type with a red marker light mounted on the roof.

Method of Operation

Trains are operated over the three main tracks between Cheyenne and Laramie by automatic wayside signals of a centralized traffic control system (CTC) supplemented by locomotive cab signals. Train crewmembers are also directed in their duties by radio-transmitted instructions from the dispatcher in Cheyenne. The tracks are numbered 1, 2, and 3 from north to south. Tracks Nos. 1 and 2 parallel each other from Cheyenne to Laramie. Track No. 3 follows a different alignment some distance south of Tracks Nos. 1 and 2 between Cheyenne and Dale Junction. At Dale Junction, track No. 3 joins track No. 2. Only tracks Nos. 1 and 2 are between Dale Junction and East Hermosa. At East Hermosa, track No. 3 begins again and parallels tracks Nos. 1 and 2 to West Hermosa. At West Hermosa, track No. 3 begins to follow a different and southwesterly alignment some distance south of tracks Nos. 1 and 2. After about 5 miles, track No. 3 curves to the northwest and again meets tracks Nos. 1 and 2 where they enter Laramie.

Through the use of crossover tracks, the dispatcher can route a train over any of the three main tracks between control points to allow the train to overtake and pass another train. The tracks are signaled in both directions and the intermediate signals are of the approach-lighted, four-aspect, color-light type. The

intermediate signals do not illuminate until a train passes the preceding signal or the circuitry in the preceding block is otherwise shunted. The signals are each mounted on a single pole to the right side of the track in the direction of travel. The home signals at East Hermosa and West Hermosa are bridge-mounted over the three tracks, except the westbound home signal for track No. 2 at East Hermosa. This signal controls movement from track No. 2 to either tracks Nos. 2 or 3 and is mounted on a single pole. Once the dispatcher has established the route for a train between home signals at switch locations called control points, the intermediate signals governing the route are automatically established for that train. The dispatcher can change the routing for a train through the switch only if the switch and track between insulated joints at clearance points is not occupied. However, the switch position and home signal will not change unless the block beyond the signal is not occupied.

If the block beyond an intermediate signal is occupied by a train, the signal will display the following aspect:

Aspect	Name	Indication
Red or red over red (with number plate)	Stop and Proceed	Stop before any part of train or engine passes the signal, then proceed at restricted speed through entire block.

If the block governed by the signal is clear and the block in advance of that block is occupied, the signal will display the following aspect:

Aspect	Name	Indication
Yellow	Approach	Proceed prepared to stop before any part of train or engine passes the next signal. Trains exceeding 30 mph must immediately reduce to that speed.

If two blocks in advance of the signal are unoccupied, but the third block ahead of the signal is occupied, the signal will display the following aspect:

Aspect	Name	Indication
Flashing Yellow	Advance Approach	Proceed. Speed passing signal must not exceed 40 mph.

If three blocks in advance of the signal are unoccupied, and the route was established for the train at the last control point, the signal will display the following aspect:

Aspect	Name	Indication
Green	Clear	Proceed

The automatic cab signal system (ACS) in locomotive unit No. 3749 of NPH-16 was designed to repeat the four basic wayside signal aspects--clear, advance approach, approach, and stop--which a train would encounter. Whenever the cab signal changed to a more restrictive aspect, the engineer was required to move the three-position acknowledging device from the "normal" to the "acknowledge" position. Failure of the engineer to do this would result in the continuous sounding of a horn located above and between the front cab windows. If the engineer failed to acknowledge within 6 seconds, the airbrakes would apply automatically at a service rate.

A dispatcher at Cheyenne directed operations over the territory in which the accident occurred. He monitored the movements of trains as they reached and passed the control points, represented by lights on the panel of his CTC console. In addition, the console was equipped with a recording graph that tracked the movements of trains by time and location. The dispatcher, according to UP instructions Nos. 100 and 101 for train dispatchers (see appendix C), was required to check the graph's timing device against the standard clock, adjust the graph for any time discrepancy, and to identify and indicate movement of each train on the graph.

The dispatchers at Cheyenne work shifts of 7 a.m. to 3 p.m., 3 p.m. to 11 p.m., and 11 p.m. to 7 a.m. According to UP instruction No. 145, before changing shifts the outgoing dispatcher is required to brief the oncoming dispatcher. Dispatchers are required to keep trains moving in an expeditious and safe manner. If trains are not moving, or are having difficulties, the dispatcher is required to determine what may be the problem. According to instruction No. 1, dispatchers must provide proper protection for all trains and guard against dangerous conditions in train movements. Instruction No. 12 requires that when weather conditions endanger the safety of trains, the dispatcher shall issue proper slow or cautionary orders and arrange for trains to be stopped or spaced to insure safety of operation.

A Superintendent's Bulletin Order A-9, which was an addition to the tables on page 148 of System Timetable No. 3, was in effect on October 16, 1980. (See appendix D.) The bulletin listed speed restrictions for trains, based on tons per operative brake, westward between Hermosa and Laramie on track No. 3. The timetable special instructions listed the amount of horsepower for the various types of locomotive units on the UP. Trains with between 60 to 80 tons per operative brake, with 1 horsepower per trailing ton of effective dynamic brake on units providing dynamic braking, were not to exceed timetable speeds from Hermosa to Laramie. Trains providing less than 1 horsepower per trailing ton of effective dynamic brake on units providing dynamic braking were not to exceed 30 mph from Hermosa to Red Buttes.

The UP notes the authorized speed of a train on clearance form No. 2643 for an engineer. The maximum authorized speed for NPH-16 on October 16, 1980, was

listed as 50 mph. This maximum speed did not apply in areas with speed restrictions and on descending grades except if authorized by special instructions.

UP "Rules and Instructions Governing the Operation of Air Brakes," on which student engineers are examined and engineers are reexamined every 2 years, contains 10 rules for the use of the dynamic brake and 2 rules for grade braking. (See appendix E.) The rules applicable to handling the brakes of a train while descending the grade on track No. 3 between Hermosa and Laramie are as follows:

> 1039A. Dynamic brake must be supplemented by use of train air brakes to extent necessary to properly control speed of train.
>
> * * *
>
> 1043. When starting freight trains from summit of heavy descending grades and pressure maintaining method of braking is to be used, care must be used to avoid making first reduction too heavy as this would reduce speed of train to extent brakes would have to be released.
>
> If first reduction was not sufficient to hold train, further brake pipe reductions of one or two pounds each may be made until amount is reached where train will be held at desired speed.
>
> Equalizing reservoir guage must be frequently observed and if any increase in pressure is shown on this gauge during time brakes are applied, this pressure should be promptly reduced to the amount indicated by this gauge before increase occurred.

A special rule listed in the UP timetable stated:

> 1042 (RW) The tables on page 148 [of the timetable] govern operation of freight trains and use of retaining valves, in territories shown. This does not modify the requirements of Air Brake Rule 1042:
>
> 1. Dynamic brake must be placed in operation and tested at a convenient location prior to reaching designated descending grades.

Meteorological Information

At 1:50 p.m., October 16, 1980, the weather station at Laramie, 15 miles west of the accident site, recorded snow showers; pockets of fog; barometric pressure, 29.63 inches; winds, 18 knots; visibility 8 miles; and temperature, 25° F. According to train crewmembers, there was no atmospheric restriction to visibility in the accident area.

Survival Aspects

The caboose on SGTLB-635 was completely crushed as a result of the collision. However, the conductor survived the accident with comparatively few injuries because he apparently was ejected through a cupola window and landed in a snowbank. The roof of the cupola was torn back from the right side where the conductor was located. (See figure 2.)

The rear brakeman in the caboose was found near the conductor's desk at the front of the caboose where he had been seated at the time of the collision. He received multiple severe crushing injuries that were instantly fatal.

The left side of the lead locomotive unit of NPH-16 was the most heavily damaged. (See figure 3.) The head brakeman was found lying on the left cab wall where the unit came to rest. He received severe multiple head and chest injuries that were instantly fatal.

Tests and Research

The recording graph from the dispatcher's CTC machine (see appendix F) was inspected to determine the routing of westbound trains and their times passing the various control points on October 16, 1980, before and just after the accident. The graph indicated that seven trains were stopped on track No. 3 ahead of SGTLB-635. Because of a snowstorm during the night, a switch west of Laramie had frozen, causing trains such as SGTLB-635 to stop and close up within blocks.

The graph indicated that SGTLB-635 arrived at Dale Junction at 1:18 p.m., and the caboose passed the signal at 1:24 p.m. The train arrived at East Hermosa at 1:29 p.m., and the caboose passed the signal at 1:32 p.m. The train arrived at West Hermosa at 1:32 p.m., and the caboose passed the signal at 1:54 p.m.

The graph indicated that NPH-16 arrived at Dale Junction at 1:36 p.m. and its caboose passed the signal at 1:42 p.m.; that the route was lined for movement from track No. 2 to track No. 3 at East Hermosa and the signal cleared at 2:19 p.m.; that NPH-16 arrived at East Hermosa at 2:58 p.m. and the caboose passed the signal at 3:02 p.m.; and that NPH-16 arrived at West Hermosa at 3:02 p.m., and its caboose passed the signal at 3:04 p.m.

The event recorder printout of NPH-16 was inspected to determine how the train was actually operated between Dale Junction and the point of collision. (See figure 4.) The printout indicated that after approximately a 4-minute stop at Dale Junction, the throttle was progressively increased from idle to 8th run position. Maximum speed between Dale Junction and East Hermosa in 8th run position was approximately 22 mph. Throttle was then reduced progressively to idle, and at approximately 10 mph, the dynamic brake was applied. A very short time later, minimum brakepipe application was made and held until the train came to a stop. After the train stopped, an additional 4-pound brakepipe reduction, for a total of 10 pounds, was made. The brake valve was released and the locomotive brakes were applied. The train remained stopped for approximately 1 hour 6 minutes. Then the independent brakes were released, and throttle was increased between 1st and 2nd run until a speed of approximately 28 mph was obtained, at which time

Figure 2.--Caboose of SGTLB-635.

Figure 3.--Locomotive unit No. 3749 of NPH-16.

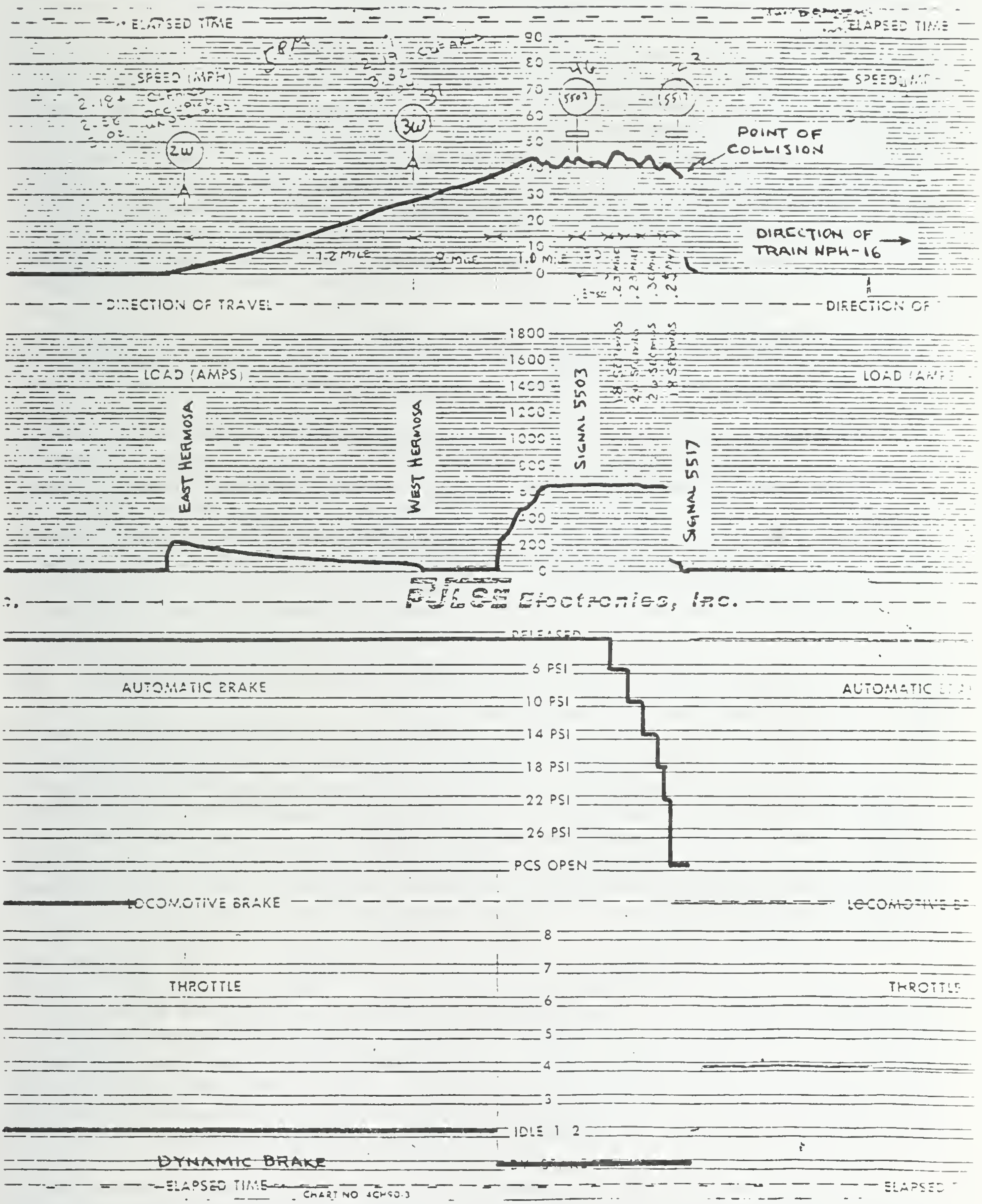

Figure 4.--Event recorder printout of NPH-16.

throttle was reduced to idle position. The train drifted for approximately 0.8 mile immediately after passing the signal at West Hermosa. Then dynamic braking was applied about 1 mile east of signal No. 5503 and progressively increased to full dynamic braking while the train accelerated to a speed of about 35 mph during the next 0.5 mile. At signal No. 5503, speed had increased to about 42 mph. After approximately 0.35 mile of continued dynamic braking west of signal No. 5503, a minimum brakepipe reduction was made. This was held for approximately 18 seconds. At this time, the speed was approximately 47 mph. Then an additional brakepipe reduction of 4 pounds, for a total of approximately 10 pounds, was made; this was held for approximately 20 seconds. Then an additional brakepipe reduction of 4 more pounds, for a total of approximately 14 pounds, was made and held for approximately 21 seconds. Then brakepipe reduction of an additional 2 or 3 pounds was made and held for approximately 5 seconds. The train's brakes were then placed into emergency about 0.25 mile east of signal No. 5517 while the train's speed was approximately 40 mph. The train continued in emergency for approximately 18 seconds, at which time there was a total loss of speed signal on the event recorder, which would indicate the point of impact.

An inspection of the cab of locomotive unit No. 3749 of NPH-16 made shortly after the accident disclosed that the automatic brake valve was in full-release position, the independent brake valve was in release position, the emergency brake handle on the brakeman's side had not been applied, the deadman foot pedal was depressed with a metal object which nullified the pedal's function, the brakepipe cut-off valve was cut in, and the brake application valve was in the lead position. The cab signal control valve was cut into the cab control system and sealed. The event recorder, manufactured by Pulse Electronics, Inc., was located inside a compartment under the deck on the left side of the locomotive. The batteries, located under the left front walkway of the locomotive, were destroyed in the accident, resulting in the loss of electrical power to the event recorder, cab lighting, and other auxiliary electrical circuits.

On October 17, 1980, a test was made of the airbrake equipment on the cars of NPH-16 that were not derailed. This test was conducted in the UP's Cheyenne Yard and observed by investigators. In the test and inspection of 55 cars, 4 cars would not make a brake application with a full service reduction and 1 car was missing a dead lever pin, which rendered the brakes ineffective on that car. Of the 55 cars inspected, 9 had ABDW brake equipment, 19 had AB brake equipment, and 27 had ABD brake equipment.

All controlling relays and circuits for the signal at West Hermosa and intermediate signals Nos. 5503 and 5517 were tested by UP and Federal investigators soon after the accident. The equipment was found to be free of defects, no evidence of tampering was found, and the equipment functioned as designed with the signals displaying proper aspects. The signal case and relays from the damaged case at signal No. 5517 were taken to Laramie and individually tested; no exceptions were noted. Circuiting for the locomotive cab signals was tested and found to be operating in accordance with the wayside signals.

On November 17, 1980, signal tests were made of the signals on track No. 3 between East Hermosa and Red Buttes. These tests, which simulated train occupancy of the various blocks similar to the occupancy on the day of the

accident, were conducted by qualified UP signalmen accompanied by Federal investigators. All signals functioned properly and no exceptions were noted.

On November 19, 1980, three stopping distance tests were made with a test train assembled to simulate NPH-16 with approximately the same tonnage, the same type and number of locomotive units, and approximately the same number of cars. (See figure 5.) The test train consisted of UP locomotive units Nos. 3747 3673, and 3773; 67 loaded freight cars and 3 empty freight cars; and the trailing tonnage was estimated to be 5,436 tons. Each unit was equipped with a Pulse tape event-recording device which was capable of recording on a magnetic tape the last 48 hours of the following functions: elapsed time, speed and distance, direction of travel, loads or amps, automatic brake application, throttle settings, dynamic braking, and independent braking.

The first test was prearranged to simulate the Pulse tape event recording data removed from locomotive unit No. 3749 on the day of the accident. In this test, the train's speed was allowed to reach 30 mph before the dynamic brake was initially applied about 0.8 mile west of West Hermosa. The throttle was advanced in dynamic braking to 6th position, about 0.5 mile from the signal at a speed of 38 mph. At signal No. 5503, the throttle was in 8th dynamic position and the speed was 46 mph. Five-tenths of a mile west of the signal, and 39 seconds later, a 6-pound brakepipe reduction was made; 32 seconds later, a further reduction of 4 more pounds was made; 35 seconds later, a further reduction of 4 pounds was made, totaling 14 pounds; and 22 seconds later, the airbrakes were applied in emergency. At the collision point, the test train's speed was 25 mph, according to the speed indicator. The lead locomotive unit of the test train stopped 1,500 feet west of signal 5517, about 1,400 feet beyond the collision point.

A second test was made to determine how the train would react if the dynamic brake was tested for effectiveness between East and West Hermosa, then later applying the dynamic brake to prevent passing signal No. 5503 at a speed not exceeding 40 mph, and immediately applying the airbrakes to reduce to a speed of 30 mph prepared to stop for signal No. 5517. After the test train was started at East Hermosa, the dynamic brake was applied about 0.25 mile west of the signal at West Hermosa at a speed of 28 mph. The speed was controlled with the dynamic brake in 7th position, and a 6-pound brakepipe reduction was made while the train passed signal No. 5503 at 40 mph. The speed decreased from 40 mph to 26 mph in 2,490 feet and then another 4-pound brakepipe reduction was made, increasing the total to 10 pounds. The lead locomotive unit of the test train stopped 4,980 feet west of signal No. 5503 and 2,194 feet east of signal No. 5517.

A third test was made to determine compliance with UP Superintendent's Bulletin A-9 of March 12, 1980, which was an additional listing to the tables on page 148 of UP System Timetable No. 3. The table required that trains of between 60 to 80 tons per operative brake, using airbrakes only, must not exceed 30 mph between Hermosa and Red Buttes. Tons per operative brake for the NPH-16 were obtained by dividing the train's tonnage (5,450) by the number of cars (69) in the train. After the test train was started at East Hermosa, the engineer allowed the speed to increase to 30 mph; about 0.4 mile west of the signal at West Hermosa, a 6-pound brakepipe reduction was made. The train, with the brakes applied, passed signal No. 5503 with the throttle in 6th position; while moving at 32 mph, the

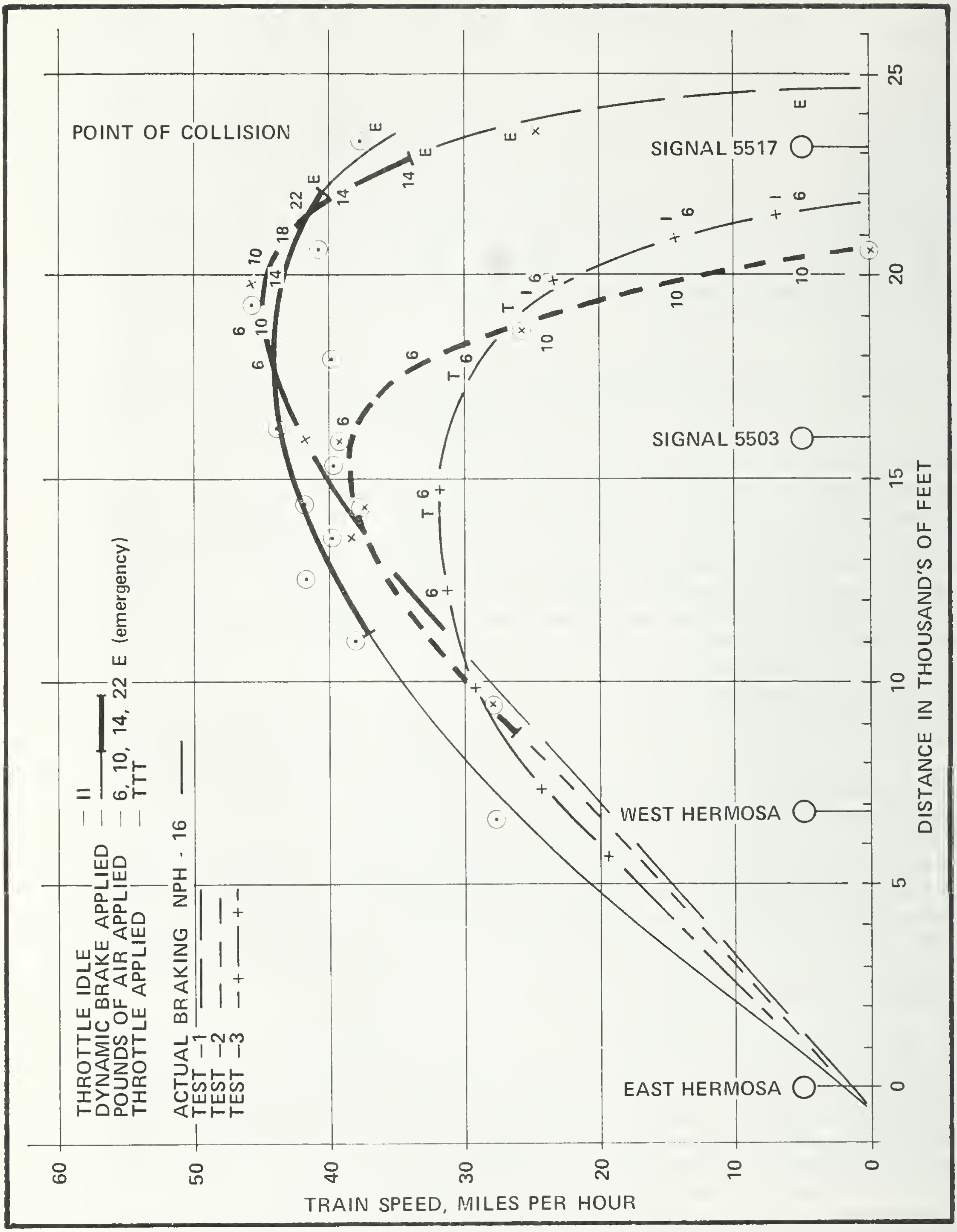

Figure 5.--Stopping distance tests of test trains.

throttle was gradually reduced to idle, 3,960 feet west of signal No. 5503. The train stopped in 2,000 feet with the lead unit 1,214 feet east of signal No. 5517.

The Air Brake Association stresses the importance of immediate action on grades when the dynamic brake is inoperative or a part of the dynamic brake becomes inoperative. 6/ A safe practice, according to the association, is to stop the train quickly. The association states that, on heavy grades, train speed can get out of control in a very short time and when use of emergency braking is apparent, a crewmember should not hesitate to use it. Service applications usually react too slowly and allow too much speed increase before the braking becomes effective. The dynamic brake is most effective prior to and at about 25 mph.

Locomotive unit No. 3749 of NPH-16 was given a series of tests on October 19, 1980, in Cheyenne to determine if the cab signals functioned as intended. The cab signal air release valve was also checked to see if the ports were open and free of obstruction. Although the locomotive unit was damaged, these test results indicated that the cab signals and safety features were functioning as intended. UP signal and mechanical personnel conducted these tests with Federal investigators.

Sight-distance tests were conducted by UP signal officials and Federal investigators on October 21, 1980, to determine where signal No. 5517 would come into view and where the caboose would come into view. The signal aspect became visible at 1,300 feet, and the caboose was sighted 1,200 feet from impact.

Other Information

The engineer of NPH-16 said that he understood the special instruction table listed in the Superintendent's Bulletin Order A-9 and that he had a "50-mph train." However, when asked how he knew this and to explain the table, he was unable to do so. In addition, he stated that he had blocked the deadman pedal because of a foot problem and also to allow him to stand when meeting trains on an adjacent track that might have a protruding, shifted load.

An engineer on an eastbound train that passed the accident site about 20 minutes after the accident said he looked back and saw the westbound signal for track No. 3 at West Hermosa with a flashing yellow aspect while NPH-16 was standing in the next block beyond. Investigators could not determine why this signal aspect would have been displayed. The signal should have displayed a steady yellow aspect after the accident. The engineer on a train that followed NPH-16 into the block about 40 minutes after the accident said the signals were working as intended.

The head brakeman of an eastbound train on track No. 2, which passed the moving NPH-16 on track No. 3 while between East and West Hermosa, said he saw both the engineer and head brakeman seated and awake in the cab of the lead locomotive unit as their locomotives passed each other.

6/ Air Brake Association, "Management of Train Operation and Train Handling," Fourth Edition, 1977. (See appendix G.)

ANALYSIS

Train Delay

Since the normal running time between Dale Junction and East Hermosa is about 10 minutes, as indicated by the movement of SGTLB-635, NPH-16 should have arrived at East Hermosa at about 1:46 p.m. after leaving Dale Junction at 1:36 p.m. Because SGTLB-635 did not leave West Hermosa until 1:53 p.m. because of the emergency brake application, the signal at East Hermosa would have been displaying a stop aspect for the approaching NPH-16. Because the signal at East Hermosa is a home signal, the engineer properly kept NPH-16 east of the signal and did not close up on SGTLB-635 while it was in the block ahead. However, when the East Hermosa signal changed to a green aspect at 2:19 p.m., and NPH-16 did not begin to move past the signal until 2:58 p.m., it suggests that both the engineer and conductor may have been inattentive to their duties.

First, according to UP operating rule 269, both the engineer and conductor of NPH-16 should have contacted each other and then radioed the dispatcher to determine why the East Hermosa signal was remaining at a stop indication for such a long time. Second, when the engineer saw the aspect change to green, he should have notified the conductor and the dispatcher of his decision not to move NPH-16 because the head brakeman was ill and not in the lead locomotive unit. If the crewmembers had communicated with each other and the dispatcher to determine why the signal at East Hermosa was remaining at stop for such a long time, they would probably have been told of the trains stopped ahead on track No. 3. The crewmembers then would have operated their train more cautiously after leaving East Hermosa and might have tried to contact SGTLB-635 to determine its stopped location. Also, if the crewmembers had known the location of SGTLB-635, any problem with the signal aspects would have become obvious to the crewmembers in the locomotive.

Since the dispatcher was unable to contact either the engineer or conductor of NPH-16 after the dispatcher had cleared the East Hermosa signal, and since both the locomotive and caboose had working radios, it becomes all the more apparent that the crewmembers were inattentive to their communication duties. However, for the dispatcher not to have radioed NPH-16 again before and after he noticed on his train graph that the train had begun to move at 2:58 p.m. indicates an inadequate concern on his part for the train's operation. This lack of action, because of handling other train problems near Laramie and possibly due to the briefing of the next shift dispatcher who was coming on duty at 3 p.m., allowed the engineer of NPH-16 to advance his train after having been stopped for over an hour, unmindful of all the trains stopped on the track ahead. This inappropriate regard by the dispatcher for NPH-16 was a factor in the accident.

The Safety Board believes that the continued dispatching of trains westbound from Cheyenne in the face of a known storm and stopped trains, which eventually had some crewmembers remaining with their trains up to 20 hours of continued service because of an inability of the UP to relieve the crews, 7/ is an operating

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7/Federal regulations (49 CFR 228) permit only a maximum of 12 hours of continued service.

practice which will strain the ability of a dispatcher and train crewmembers to function at a safe level of competence. Under such adverse conditions, more communication among crewmembers and the dispatcher becomes a necessary supplement to the signal system, a system which would be allowing trains to proceed under the possible tired or anxious watchfulness of their crewmembers. In addition, this communication should include any problems encountered by the crewmembers and the dispatcher and should be automatically recorded, if possible, for corrective action.

As a result of its investigation of the head-on collision of two Penn Central freight trains near Pettisville, Ohio, on February 4, 1976 8/ the Safety Board recommended that the Federal Railroad Administration (FRA) require enginecrews to communicate fixed signal aspects to conductors while trains are en route on signalized track to help keep each other alert. The FRA responded that such a requirement would be difficult to regulate, and the FRA has not established such a requirement.

Signal Operation

The engineer of SGTLB-635 stated that he received a flashing yellow aspect at West Hermosa, a yellow aspect at signal No. 5503, and a red aspect at signal No. 5517 before proceeding beyond signal No. 5517 and stopping his train within the block behind another train. None of the previous trains during the morning of October 16, 1980, had reported any problems with the signals between East Hermosa and Laramie even though the storm had been more severe at that time. The engineer of NPH-16 should have received the same signal aspects as SGTLB-635 when leaving East Hermosa about 1 hour after SGTLB-635 had stopped with its caboose about 100 feet west of signal No. 5517. The engineer of the train following NPH-16 said that he stopped east of signal No. 5503 because it was displaying a red aspect; the rear portion of NPH-16 would have been occupying the block ahead at the time. Postaccident tests of the signal system after the accident indicated that the signal system was functioning properly. Therefore, the Safety Board concludes that the signal system was working properly at the time of the accident.

The Safety Board is unable to determine why the engineer of NPH-16 could have seen green aspects, as he said he did, on the signal at West Hermosa and the two intermediate signals Nos. 5503 and 5517. In addition, the Safety Board cannot determine why the engineer of an eastbound train, when looking back at the westbound signal for track No. 3 at West Hermosa would have seen a flashing yellow aspect on the signal instead of a constant yellow. A flashing yellow at West Hermosa would indicate that signal No. 5503 was displaying a yellow aspect and that signal No. 5517 was displaying a red aspect. A constant yellow aspect should have been displayed after the accident, and it apparently was according to the engineer of the following eastbound train on track No. 3.

8/"Railroad Accident Report--Head-on Collision of Two Penn Central Transportation Company Freight Trains Near Pettisville, Ohio, February 4, 1976" (NTSB-RAR-76-10).

Instances of a signal displaying a so-called "false-clear" 9/ aspect have been reported at times and confirmed each year throughout the country on various railroads. However, these circumstances are rare and, when investigated, it has been found that the signal will continue to display the improper aspect under the reported circumstances. These conditions normally are caused by worn relays or contacts in signal equipment, and at times by improper repair or rewiring. Postaccident tests in this case did not disclose any malfunctioning signal equipment or conditions and the train following NPH-16 did not encounter any improperly displayed signal aspects.

Train Handling

Since the locomotive crewmembers of NPH-16 were observed to have been seated in their lead unit when about halfway between East and West Hermosa by crewmembers of an eastbound train that was moving on the adjacent track No. 2, and more importantly because it is an unsafe practice and against UP rules, the need for the deadman safety pedal of NPH-16 to have been blocked and nullified to allow the engineer to stand for safety reasons when meeting trains on his side is questionable. However, since the engineer was continually awake, as indicated by the event recorder, the nullifying of the deadman pedal did not contribute to the accident.

Since NPH-16 had started from a stop at East Hermosa and was only moving about 28 mph when the locomotive passed the West Hermosa signal, it was not possible to determine from the event recorder if the train was moving for either a green aspect, which allows 50 mph, or a flashing yellow aspect, which should have been displayed and which allows 40 mph. However, regardless of which signal aspect was displayed at West Hermosa, the engineer should have tested and begun applying the dynamic brakes before entering the average 1.8-percent descending grade after West Hermosa at over 30 mph. Since the event recorder, contrary to the engineer's statement, indicates that he did not apply the dynamic brake until his train was moving over 35 mph, he had by then lost more than 30 percent of their effective braking capability. This braking capability also would have continued to decrease to approximately 50 percent as the speed increased to about 47 mph at 0.35 mile west of signal No. 5503. According to UP airbrake rules, if the dynamic brake is less than 1 horsepower per trailing ton, the maximum allowable speed for a train such as NPH-16 down the descending grade at Hermosa would have been 30 mph. Consequently, the engineer should have begun applying the dynamic brake before reaching 25 mph for better control on the grade and pending use of the airbrakes when moving between 30 and 50 mph, or he should have begun using the airbrakes sooner and not have allowed the train to obtain a speed greater than 30 mph on the descending grade. In either case, the engineer would have been able to stop the train short of the SGTLB-635's caboose according to the postaccident braking tests.

Since the event recorder indicated that the train was moving about 42 mph when it passed signal No. 5503, an engineer not properly informed about the use of the dynamic brake and its ability to stop a train on a 1.8-percent descending grade could still have believed he was not exceeding the authorized speed if the signal

9/Displaying a green or less restrictive aspect than should have been shown.

was displaying either a green or yellow aspect. According to the event recorder, it was only after passing signal No. 5503 that the engineer may have become aware that there was difficulty controlling the train's speed. This was evident when the engineer began to apply only the dynamic brake and the train speed continued to increase to about 47 mph even though the dynamic braking had been quickly increased to its maximum. If signals Nos. 5503 and 5517 had displayed green aspects allowing 50 mph, there would have been no need for the engineer to have quickly made a number of successive and increasing applications of the train's airbrakes which reduced the train's speed to 40 mph about 1,200 feet before signal No. 5517. Since a 10 pound or less airbrake application would have been sufficient to maintain the train's speed under 50 mph, the airbrake applications of more than 10 pounds indicate that the engineer was braking the train for a stop beginning about 0.5 mile east of and before he saw signal 5517.

The postaccident sight distance tests indicated that the engineer of NPH-16 would have been able to first see signal No. 5517 and the red marker light on the caboose of SGTLB-635 from about 1,200 feet, which is the point at which he first made an emergency brake application. Since the engineer was unable to do anything more to reduce the speed of his train, he was most likely the person who radioed the crewmembers of SGTLB-635 to get off of the caboose just prior to the collision.

Since the Safety Board believes that the signals were functioning properly, and since the postaccident tests of locomotive unit No. 3749's cab controls indicated they were operating properly, the Safety Board concludes that the engineer properly acknowledged the restrictive cab signals as the train passed the flashing yellow signal aspect at West Hermosa and the yellow aspect at signal No. 5503. The engineer of NPH-16 apparently thought that his maximum application of the locomotive's dynamic brakes would reduce the 42-mph speed of his train after it passed signal No. 5503. Instead, the brake application was ineffective and allowed the train's speed to actually increase. The Safety Board concludes that when the engineer first realized that the dynamic brakes were not going to slow his train, the train had traveled too far into the approximate 7,000-foot block for the train to stop with use of the train's airbrakes before reaching signal No. 5517.

Airbrake Rules and Speed Instructions

As an experienced engineer, the engineer of NPH-16 should have known that the dynamic brake is most effective up to 25 mph, a speed the train was traveling between East and West Hermosa. Had he made an initial application of the dynamic brake at that time, as required by rule 1042 (RW), he would have known how effective the dynamic brake was. Therefore, he would have known what actions were required to properly control the train's speed descending the 1.8-percent grade if the dynamic brake was not functioning properly. Since the locomotive units of NPH-16 were extensively damaged, it was not possible to determine how effective the dynamic brake may have been prior to the collision. However, in the braking test which duplicated the engineer's handling of the train, the test train with the effective dynamic brake was also unable to slow or stop before signal No. 5517. Therefore, the dynamic brake on NPH-16 apparently was working properly.

It was important that the engineer understand how to determine how many tons per operative brake his train had before descending the steep grade over 1.5 percent. However, the airbrake rules of the UP do not adequately explain when the dynamic brake is effective, nor do the timetable special instructions adequately explain how to determine a train's tons per operative brake. The Safety Board believes that if engineers and other crewmembers are supposed to know how to interpret and apply the special instructions which are related to the use of the dynamic brake, there should be additional train handling and airbrake rules which supplement these instructions.

Rules and Examinations

The inability of the engineer of NPH-16 to explain how he would apply the special instructions to his train indicates that the UP rules and the engineer's examination of the rules may have been inadequate. Since the UP requires its engineers to be reexamined on the "Operating Rules and Instructions Governing Operation of Air Brakes" only once every 2 years, and because the engineer of NPH-16 had not received either instruction or examination of these rules since May 18, 1978, it is evident that the engineer of NPH-16 probably was not adequately instructed or kept abreast of changes such as those stressed by the Air Brake Association. Since the Safety Board has investigated four other accidents on the UP since March 1979, 10/ and is currently investigating another major accident on the UP, 11/ all of which have involved either improper train handling, poor equipment inspection, or human factors, the Safety Board concludes that UP employees are apparently not adequately instructed concerning UP rules, nor are they properly examined on the rules.

Event Recorder

The Safety Board commends the UP for the installation of the event recorders on its locomotives. The event recorder was very helpful in determining the actual speed of NPH-16, the use of the dynamic brake, the airbrake applications, the throttle positions, and the time elapsed as the train approached the point of collision. However, it did not record the engineer's acknowledgment of the restrictive signals when they were passed. If movement of the acknowledging lever had been recorded, it would have been possible to confirm which signals had restrictive aspects. In its investigation of the derailment of Amtrak train No. 4 at Lawrence, Kansas, on October 2, 1979, 12/ the Safety Board also found that it

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10/ "Railroad Accident Report--Rear-End Collision of Two Union Pacific Freight Trains, Ramsey, Wyoming, March 29, 1979" (NTSB-RAR-79-9);
"Railroad Accident Report--Derailment of Union Pacific Railroad Freight Train, Granite, Wyoming, July 31, 1979" (NTSB-RAR-79-12);
"Railroad Accident Field Investigation--Derailment of Union Pacific Freight Train, Albany, Wyoming, February 11, 1980" (NTSB-DEN-80-FR-013);
"Railroad Accident Field Investigation--Derailment/Collision of Union Pacific Freight Trains, Granite, Wyoming, October 13, 1979" (NTSB-DEN-80-FR-001).

11/ Rear-end collision of two Union Pacific Railroad Company freight trains at Kelso, California, on November 17, 1980.

12/ "Railroad Accident Report--Derailment of Amtrak Train No. 4, on the Atchison, Topeka and Santa Fe Railway Company, Lawrence, Kansas, October 2, 1979" (NTSB-RAR-80-4).

would have been possible to determine if the engineer had acknowledged the automatic train stop (ATS) inductor if the event recorder had been adapted to record that event. Since such information would be useful in determining if signal systems or ATS equipment is functioning properly, the Safety Board concludes that acknowledgment of such safety systems should be recorded.

Although the event recorder was not damaged in this collision, it was located in a forward area of locomotive unit No. 3749 that was easily damaged in the collision. Also, the locomotive batteries were destroyed in the accident, causing a loss of power to the recording device, radio, and cab lights. Even if the engineer had been able to summon help on the radio, he could not have done so because of the loss of power from the batteries. As a result of its investigation of the Lawrence, Kansas, accident, the Safety Board recommended to the FRA that emergency lights and power be provided on passenger train equipment. The FRA responded that it is evaluating necessary emergency requirements and hopes to complete its study in the near future. The Safety Board believes that emergency power and lights should also be provided on locomotives.

CONCLUSIONS

Findings

1. The crewmembers of NPH-16 were inattentive to their communication duties while stopped at East Hermosa for about 1 hour and should have had radio communication with one another and the dispatcher concerning the signal delay and any other problems.

2. The dispatcher should have shown more concern and tried more often to have radio communication with NPH-16 crewmembers to determine why the train did not move promptly after the signal was cleared at East Hermosa.

3. It may be beneficial that radio communications between crewmembers and the dispatcher be recorded for identifying and recording problems.

4. Because of the storm and train delays, the burdens of the job increased and the dispatcher may not have been able to function at the level of expertise required by his job.

5. Other train movements and signal tests indicate that the wayside signals and the locomotive cab signals which governed the movement of NPH-16 from East Hermosa to the accident location functioned properly.

6. The engineer of NPH-16 did not adequately use the train's dynamic brake and airbrakes for controlling the speed of the train after leaving West Hermosa.

7. The engineer of NPH-16 was unaware that his delayed use of the dynamic brake long after entering the descending grade at West Hermosa required that the train's speed should not increase over 30 mph.

8. UP train handling rules do not include instructions on when to apply the dynamic brake on descending grades, at what speeds the dynamic brake is most effective, and what procedure to follow when the dynamic brake fails on a descending grade.

9. The nullifying of the deadman safety control pedal by the engineer of NPH-16 had no effect on the accident.

10. The engineer of NPH-16 had not been examined on the UP rules within the required previous 2 years, and he did not adequately know the UP special instructions.

11. The human-failure type of accidents that have occurred on the UP during the past 2 years indicate inadequate instructions, training, and rules examinations of operating employees.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the inadequacy of Union Pacific rules in explaining train handling and braking procedures, along with the engineer's lack of comprehension of those rules and his inadequate handling of the train's brakes, which resulted in his failure to bring the train to a stop as required before reaching signal No. 5517. Further, there was a lack of necessary communication among train crewmembers and with the dispatcher.

RECOMMENDATIONS

As a result of this investigation, the National Transportation Safety Board made the following recommendations:

--to the Union Pacific Railroad Company:

> Establish rules and procedures which require enginecrews to communicate fixed signal aspects to conductors while trains are en route on signalized track. (Class II, Priority Action) (R-81-41)
>
> Amend and clarify rules to require dispatchers and train crewmembers to communicate with each other about conditions affecting the movement of their train. (Class II, Priority Action) (R-81-42)
>
> Expand the rules and instructions governing the use of the dynamic brake to include conditions of when to apply the dynamic brake on a descending grade, at what speeds the brake is most effective, and what action to take when the dynamic brake has

failed prior to or while being applied. (Class II, Priority Action) (R-81-43)

Improve training, evaluation, and examination of train crewmembers so that they become and remain proficient in the train handling and special instruction aspects of their territories. (Class II, Priority Action) (R-81-44)

Modify event recorders to record activation of the cab signal acknowledging lever. (Class II, Priority Action) (R-81-45)

Relocate event recorders so as to lessen the likelihood of their becoming damaged in an accident. (Class II, Priority Action) (R-81-46)

Provide the cabs of locomotives with emergency power so that emergency lights, radios, and event recorders continue to operate when normal power is lost. (Class II, Priority Action) (R-81-47)

--to the Association of American Railroads:

Encourage member railroads to establish rules that require enginecrews to communicate fixed signal aspects to conductors while trains are en route on signalized track. (Class II, Priority Action) (R-81-48)

Encourage member railroads to have event recorders which record activation of cab signal, automatic train stop, or other similar safety system devices. (Class II, Priority Action) (R-81-49)

Encourage member railroads to install or relocate event recorders so as to lessen the likelihood of their becoming damaged in an accident. (Class II, Priority Action) (R-81-50)

Encourage member railroads to provide the cabs of locomotives with emergency power so that emergency lights, radios, and event recorders continue to operate when normal power is lost. (Class II, Priority Action) (R-81-51)

In addition to these recommendations, the Safety Board reiterates and reemphasizes the importance of the following recommendations which were made to the Federal Railroad Administration as a result of other train collisions:

"Promulgate rules to require engine crews to communicate fixed signal aspects to conductors while trains are en route on signalized track. (R-76-50)"

"Promulgate regulations which require an adequate backup system for mainline freight trains that will insure that a train is controlled as required by the signal system in the event that the engineer fails to do so. (R-76-3)"

"Promulgate regulations to require locomotives used in trains on main tracks outside of yard limits to be equipped with operating event recorders. (Class II, Priority Action) (R-78-44)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

ELWOOD T. DRIVER, Vice Chairman, and G. H. PATRICK BURSLEY, Member, did not participate.

April 7, 1981

APPENDIX A

INVESTIGATION

Investigation

The National Transportation Safety Board was notified of the accident about 7 p.m., e.d.t., on October 16, 1980. The Safety Board immediately dispatched an investigator from its Denver Field office and an investigator from Washington, D.C., to the scene. The investigation was completed with assistance from the Federal Railroad Administration and the Union Pacific Railroad Company.

Depositions

A 2-day deposition proceeding was held in Cheyenne, Wyoming, on December 9 and 10, 1980. Parties which participated in the proceeding were the Union Pacific Railroad Company, Brotherhood of Locomotive Engineers, and the United Transportation Union. Statements were taken from 13 witnesses.

APPENDIX B

TRAIN CREWMEMBER INFORMATION
EXTRA 3749 WEST (NPH-16)

Engineer Leonard E. Rottman

Engineer Rottman, 51, was employed as a student fireman by the UP at Cheyenne on June 23, 1950. He was promoted to fireman on July 13, 1950. On July 30, 1954, he was promoted to hostler, and on May 1, 1969, he passed the examination for promotion to engineer.

Mr. Rottman's service record indicates he had been disciplined four times since becoming an engineer. In 1971 he was given 45 demerits for damage to a yard engine. During April 1974 he was held responsible for a collision between his yard engine and another engine and a Jordan Spreader. During November 1974 he was dismissed for 6 months because of two incidents: failure to properly control the speed of his train between Laramie and Medicine Bow, and backing his locomotive into another train. He was last disciplined in April 1978 after he failed to control the speed of his train at 50 mph and passed a location at 61 mph. He passed a company physical examination on May 2, 1978, and was required to wear eyeglasses while on duty. He passed his last airbrake rules examination on May 18, 1978, and his last operating rules examination on April 10, 1980.

Conductor Keith D. Jacobs

Conductor Jacobs, 60, was employed as a brakeman by the UP at Cheyenne on November 20, 1941. He was promoted to conductor on September 25, 1950. Mr. Jacobs' service record indicates he had been disciplined three times since becoming a conductor. He was dismissed for about 19 months because of being drunk and resisting arrest on April 22, 1958. He was again dismissed for about 14 months because of being absent from his assignment on October 5, 1978. He was given a reprimand on September 9, 1980, for failure as conductor to notify his engineer or dispatcher of two cars in his train which were restricted to 40 mph while his train was given clearance for 50 mph. He passed his last airbrake rules examination on October 10, 1979, and his last operating rules examination on the same date. He passed his last physical examination on October 13, 1980, without any restrictions.

Head Brakeman Isaac K. Ortiz

Brakeman Ortiz, 22, was employed as an extra gang laborer in the UP track department at Cheyenne on September 21, 1977. He transferred to switchman at Cheyenne on March 3, 1978. He was promoted to sectionman on August 15, 1978, and later relinquished his sectionman rights to become a brakeman on December 21, 1978. He entered brakeman training on December 26, 1978, and became a brakeman on January 13, 1979.

Mr. Oritz's service record indicates he had been disciplined three times since becoming a brakeman. In July 1979 he was given 30 demerits for failure to properly line a derail which caused a locomotive to derail. In July 1979 he was

given 30 demerits for failure to report for duty. In August 1979 he was given a reprimand for being responsible for a run-through switch resulting in a derailment. He passed his last physical examination on December 21, 1978, without any restrictions. He passed his entrance and last airbrake rules examinations on January 13, 1979, and passed his last operating rules examination on the same date.

Rear Brakeman Ray A. Fernandez

Brakeman Fernandez, 26, was employed as an extra gang laborer in the UP track department at Cheyenne on August 7, 1973. He became a sectionman on August 11, 1977, at Hermosa, and was reemployed as a brakeman on December 11, 1978, at Cheyenne.

Mr. Fernandez's service record indicates he had been disciplined four times as an extra gang and sectionman, and once since becoming a brakeman. On May 15, 1975, he was dismissed for leaving work without authorization. He was given 30 demerits in June 1978 for being late to work, 30 demerits in July 1978 for failure to report to work, and 30 demerits and dismissed on July 31, 1978 for failure to report to work. As a brakeman, he was given 30 demerits for failure to report to work June 1980. He passed his last physical examination on November 9, 1978, without any restrictions. He passed his entrance and last airbrake examinations on December 11, 1978, and his last operating rules examination on November 1, 1979.

APPENDIX C

EXCERPTS FROM UNION PACIFIC RULES FOR TRAIN DISPATCHERS

Form 2274

INSTRUCTIONS

FOR

TRAIN DISPATCHERS

EFFECTIVE MAY 1, 1972

DUTIES OF TRAIN DISPATCHERS

1. Train dispatchers must provide proper protection for all train movements in accordance with rules or special instructions. They must guard against dangerous conditions in train movements and unsafe or confusing combinations of train orders.

2. Train dispatchers must not authorize or instruct agents, operators, maintenance of way employes or others to handle switches for trainmen except when such employe is assigned that duty.

3. Train orders, messages, line-ups and instructions must be transmitted with care and at a speed regulated to the capacity of the person receiving them. Special care must be used when working with new or inexperienced employes.

4. A bulletin book must be maintained in each train dispatchers' office in which all superintendent's bulletins in effect in the territory assigned that office must be maintained. Train dispatchers must review bulletins before going on duty and must record the number of the last bulletin on the train sheet.

One bulletin book will be sufficient at each location where train dispatchers are employed unless local conditions indicate that more than one book is desirable or necessary.

5. Train dispatchers must be courteous in their conversations with other employes. They must not engage in arguments with operators, conductors, engineers or others regarding train orders or rules but must issue such instructions or train orders as are necessary to clarify and report the facts to the chief train dispatcher.

6. Train dispatchers must maintain such records as are required by rules, instructions or by law. Such records must be neat and legible and must be kept in the manner prescribed. It must be borne in mind that it may be necessary to produce these records in a court of law.

7. The following Maintenance of Way and Signal Rules pertain, either directly or indirectly, to the duties of a train dispatcher. Train dispatchers must be familiar with these rules:

3	101	765	1501(D)	1601
12(A)	101(B)	771	1501(E)	1604
12(B)	715	777	1501(L)	1605
12(C)	751	779	1502	1811
99(P)	758	790	1502(B)	
99(Q)	759	1501	1502(C)	
99(R)	762(A)	1501(A)	1502(D)	
99(S)	763	1501(B)	1509(A)	

MOVEMENT OF TRAINS

12. When weather conditions, high water, defects in track or signals endanger the safety of trains, train dispatcher must issue proper slow or cautionary orders, arrange for trains to be stopped or spaced, or take whatever action is necessary and appropriate to insure safety of operation.

* * *

AUTOMATIC CAB SIGNALS

98. When report is received by the train dispatcher that cab signal devices on an engine are inoperative, he may verbally authorize the engineer to cut out such devices in the following form:

> *"You may cut out cab signal devices on Eng ______ and proceed being governed by Rule 458"*

Record of authority granted to cut out cab signal devices must be made on the train sheet.

99. When it is known in advance that ACS will be inoperative in a specified territory, authority to cut out cab signal devices will be furnished trains affected by train order in the following form:

> *"From eight one 801 AM until four one 401 PM April 4 cab signals will be inoperative between __________ and __________ Be governed by Rule 457"*

CENTRALIZED TRAFFIC CONTROL

100. As soon as practicable after going on duty, each train dispatcher operating a CTC control machine must check the traingraph with a standard clock. He must record on the graph date and time comparision was made, accuracy of the graph at that time, and sign the graph.

When traingraph is running fast or slow, it must be adjusted to correct time and notation of correction made on graph.

101. The train dispatcher must indicate on the traingraph the identification of each train and must draw lines connecting automatic recordings to show the movement of each train.

102. Within CTC territory controlled signals must be displayed at their most restrictive indication except that signals must be cleared sufficiently in advance of a movement to avoid giving an unnecessary restrictive indication.

Switches must be restored to normal position as soon as practicable after a movement has been completed.

103. Controls must not be operated to change position of a switch while a train or engine is occupying "OS" section.

104. When switches or signals are undergoing repairs, train dispatcher must block switches or signals affected and must not remove blocks until advised that repairs have been completed.

When safe to do so and it will not interfere with movement of trains, switches and signals may be operated upon request from signal maintainer or maintenance of way foreman for test purposes or for movement of heavily loaded track cars.

E-105. Reference Rule 270, track and time limits.

After the train or engine has entered the specified limits, the train dispatcher must block signals controlling movement into the specified limits and must not permit any other train or engine to enter those limits during period track and time limits are in effect except as provided in Rule 270 (A). Blocks must not be removed until track and time limits have expired or have been released by conductor or by the member of the crew to whom they were given.

106. Form C clearance to authorize a train or engine to proceed from a Stop signal must be handled as follows:

If train dispatcher knows there is no opposing movement or any movement holding track and time limits between that signal and the next Stop signal in advance, instructions must be given thus:

"C&E ________________
This clearance is authority to proceed on ________ track from Stop signal at ________ at restricted speed to the next signal"

E-106 (A). When the train dispatcher is not positive that there is no opposing movement between the Stop signal and the next Stop signal in advance, or when track and time limits for another train or engine are in effect, and it is necessary to permit the train or engine to proceed, the train dispatcher must instruct that train or engine be moved forward until leading wheels are 100 feet past Stop signal and wait 10 minutes before acting on Form C clearance. After acknowledgment of these instructions has been received from the employe requesting authority to proceed, Form C clearance may be issued as provided in Item 106 above.

O-106 (B). When the train dispatcher is not positive that there is no opposing movement between the Stop signal and the next Stop signal in advance, or when track and time limits are in effect, and it is necessary to permit train or engine to proceed, instructions must be given thus:

"C&E ________________
This clearance is authority to proceed on ________ track from Stop signal at ________ under flag protection"

* * *

AIR BRAKES

144. Air brake rules require that each train must have all air brakes in operation, except in emergency, but at no time may the number of operative brakes be less than permitted by Federal requirements.

When air brakes fail, an engine must not be permitted to move itself, or cars, except to clear main track, and then only if it can be safely done.

DISPATCHER'S TRANSFER

145. When a train dispatcher is relieved, he must make written transfer, in ink, on a separate page in train order book.

Train dispatcher going off duty must show the number of each train order in effect (including slow or cautionary orders) and relieving train dispatcher going on duty must write opposite each order number a brief synopsis of his understanding of the order. This synopsis may be abbreviated but not to the extent that it cannot be read and understood by another person if necessary.

Transfer must show track car operator's line-ups still in effect and, in CTC territory, must show location of trains, motor car permits which have not expired, any irregularities in equipment and any movements being made under authority of Form C clearance.

Train dispatcher going off duty must verbally call attention of relieving train dispatcher to position of trains, any unusual work they have to do, orders they will probably need, or any unusual situation. When unusual conditions exist, train dispatcher going off duty must explain to relieving train dispatcher what has been done or may be necessary in the way of spacing or otherwise protecting train movements.

Both train dispatchers must be sure that any unusual condition is understood.

Transfer must be initialled and timed by both train dispatchers.

* * *

EASTERN AND SOUTH-CENTRAL DISTRICTS AND IDAHO DIVISION

OPERATING RULES

EFFECTIVE MAY 1, 1972

85. When a train is delayed, other trains must be allowed to pass promptly. Conductors and engineers will be held jointly responsible for unnecessary delays to trains.

85 (A). The train dispatcher must be advised in advance of any known condition that will delay the train or prevent it from making usual speed.

101. Trains and engines must be fully protected against any known condition which interferes with their safe passage at normal speed.

When conditions are found which may interfere with safe passage of trains or engines at normal speed and no protection has been provided, the radio, telegraph or telephone must not be depended on to notify other trains; protection must be provided in accordance with Rule 99 and a report must be made to train dispatcher by quickest means of communication.

If any member of a train or engine crew has reason to believe that their train or engine has passed over any dangerous defect, the train or engine must be stopped at once and protection provided.

101 (A). During severe storms or when there is indication of high water or any condition which threatens damage, trains must move at restricted speed. Conductors and engineers must make inquiries at stopping places and when, in their judgment it is necessary, must make extra stops to ascertain the extent and severity of storms and to examine bridges, culverts or other places subject to damage.

When a train is flagged by a track patrolman, in case of storm or indication of storm or high water, patrolman must patrol track ahead of train through the storm area.

101 (B). Trains or engines must not pass over broken rail on curve until joint bars have been securely fastened on both sides of rail at the break. On straight track, trains and engines must stop not less than 200 feet from broken rail and, if considered safe to do so, may proceed if a responsible employe, prepared to give stop signal, watches the movement over the break, but a speed of five miles per hour must not be exceeded.

102. When a train becomes disabled or is stopped suddenly by an emergency application of the brakes or other causes, a lighted red fusee must be immediately displayed on adjacent track at front and rear of train, and adjacent track as well as tracks of another railroad that are liable to be obstructed must immediately be protected in both directions in accordance with Rule 99 until it is ascertained they are safe and clear for the movement of trains. After lighted fusee has been displayed at front of train, headlight must be extinguished.

In such cases, it must be determined by inspection that the train involved and the track to be used are safe for the train to proceed. Train involved must not proceed nor may flagmen be recalled until engineer has been definitely advised by conductor that it is safe to do so.

A train on an adjacent track must not pass the disabled train unless it is preceded by a flagman or unless definitely assured by the conductor of the disabled train that the track is clear and it is safe to proceed.

* * *

RULES GOVERNING OPPOSING AND FOLLOWING MOVEMENT OF TRAINS BY BLOCK SIGNALS

261. On portions of the railroad and on designated tracks so specified in the time-table, trains will be governed by block signals, whose indications will supersede the superiority of trains for both opposing and following movements on the same track.

262. The reverse movement of a train or engine must not be made except by signal indication or as prescribed by Rule 270, without permission of control operator.

263. Movement of trains will be supervised by the train dispatcher who may also operate the control machine.

When the control machine is operated by other than the train dispatcher, the train dispatcher will issue necessary instructions to the control operator.

264. Except as affected by Rules 261 through 263, all Operating Rules remain in effect.

CENTRALIZED TRAFFIC CONTROL SYSTEM RULES

265. Centralized Traffic Control System Rules apply only in CTC territory as specified in the time-table or in special instructions.

Rules 261 through 264 apply in CTC territory.

Except as affected by Rules 261 through 271, all Operating Rules remain in effect.

266. A train or engine must not enter CTC territory unless the governing signal displays an indication to proceed or authority is obtained from the control operator.

267. A train or engine must not foul or enter the main track or a controlled siding at a hand operated switch unless the governing signal displays an indication to proceed, or authority to occupy such track has been received from the control operator.

268. A train or engine must not clear the main track at a hand operated switch not equipped with a mechanical time lock or an electric lock except as follows:

(1) Where maximum authorized speed on main track over such switch is 20 MPH or less; or

(2) When main track switch is kept open.

269. When a train or engine is stopped by a Stop signal and no conflicting movement is evident, a member of the crew must immediately communicate with the control operator and be governed by his instructions. Authority to proceed will be given by Form C Clearance which must be copied by a member of the crew, repeated to the control operator and delivered to the engineer.

When authorized to proceed, train or engine may proceed at once at restricted speed to the next signal except that when so instructed by the control operator, train or engine must be moved forward until leading wheels are 100 feet past the Stop signal, wait ten minutes, then proceed at restricted speed to the next signal.

Exception: – Clearance Form C will not be required when movement is leaving the main track, is leaving CTC territory, or the entire movement is within yard limits.

269 (A). When stopped by a Stop signal and communication with the control operator has failed, train or engine must not proceed except on signal indication or until communication is restored and authority is received from the control operator.

Exception: A train or engine stopped by a Stop signal at the entering signal at a station and unable to communicate with the control operator may move forward, when preceded by a flagman, to the leaving signal at that station, clearing main track when practicable.

269 (B). Emergency push buttons installed in telephone booths of relay houses at dual control switch locations may be used in an attempt to obtain proceed signal indication only when so instructed by the control operator, or when communication has failed.

When instructed by the control operator to use emergency push button for the desired direction, if indication permitting train to proceed is received on governing signal, train or engine may proceed in accordance with the signal indication.

When stopped by a Stop signal and communication has failed, proper emergency push button may be used, and if indication permitting train to proceed is then received, train or engine may proceed but must move at restricted speed to the next Stop signal, keeping a close look out for track car or for men and equipment on track without flag protection.

269 (C). If a train or engine fails to stop before passing a signal displaying Stop indication, front of train must be protected immediately as prescribed by Rule 99. A member of crew must communicate with control operator at once and be governed by his instructions.

APPENDIX D

EXCERPTS FROM UNION PACIFIC OFFICE OF SUPERINTENDENT BULLETIN ORDER NO. 9 AND EXCERPTS FROM SYSTEM TIMETABLE NO. 3

UNION PACIFIC RAILROAD COMPANY
OFFICE OF SUPERINTENDENT
BULLETIN ORDER

No. A-9 CHEYENNE, WYOMING-March 12, 1980

TO: TRAINMEN, ENGINEMEN AND YARDMEN

TO BE POSTED AT: WYOMING DIVISION BULLETIN BOOKS

Tables listed on Page 148 of System Timetable No. 3, covering operation of freight trains and use of retaining valves are cancelled and following tables apply:

WESTWARD

HERMOSA to LARAMIE
No. 3 Track

TONS PER OPERATIVE BRAKE	EFFECTIVE DYNAMIC BRAKE ON UNITS PROVIDING	RETAINING VALVES	SPEED MUST NOT EXCEED
Less Than 60		Refer to Special Rule 1042(R-1) P.139	Timetable speeds.
60-80	1 HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	Timetable speeds.
	Less Than 1 HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	30 MPH Hermosa to Red Buttes.
80-100	1 HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	35 MPH Hermosa to Red Buttes.
	½ HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	25 MPH Hermosa to Red Buttes.
	Less Than ½ HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	20 MPH Hermosa to Red Buttes
Over 100	1 HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	30 MPH Hermosa to Red Buttes
	Less Than 1 HP Per Trailing Ton	Refer to Special Rule 1042(R-1) P.139	20 MPH Hermosa to Red Buttes

SYSTEM TIMETABLE NO. 3

Effective 12:01 A.M., March 9, 1980

APPENDIX 11

TONNAGE RATINGS FOR ONE LOCOMOTIVE UNIT

FOR FREIGHT TRAINS AVERAGING 50 GROSS TONS PER CAR
RATINGS APPLY AT THE INDICATED MINIMUM CONTINUOUS SPEED

EASTERN DISTRICT		70-98B 5000 HP EMD DD35	100-129 1500 HP EMD GP7	131-349 1750 HP EMD GP9	305-347 470-499 2000 HP GP9M GP20	400-448 2400 HP EMD SD24	450-459 1500 HP EMD SD7	700-739B 800-875 2250 HP EMD GP30	740-763 2500 HP EMD GP35	1400-1409 2500 HP EMD SDP35	2000-2059 2000 HP GP38-2	2800-2809 2800 HP GE U28C	2810-2959 2400-2459 3000 HP U30C C30-7	3000-3858 99 3000 HP SD40 SD40-2	1-50 3600 HP EMD SD45	6900-6946 6600 HP EMD DD40X	8000-8099 3000 HP EMD SD40-2	9000-9005 3500 HP EMD GP40X
		12 MPH	12 MPH	12 MPH	14 MPH	10 MPH	6 MPH	12 MPH	12 MPH	12 MPH	11 MPH	11 MPH	10 MPH	11 MPH	11 MPH	11 MPH	9 MPH	11 MPH
Co Bluffs	To Valley	6000	2250	2650	2550	4050	2700	2950	3000	3650	3150	4500	5250	4900	4950	5800	4150	2900
Valley	To No Platte	9700	3650	4250	4100	6550	4350	4750	4850	5900	5050	7250	8500	7850	7950	9350	6700	4700
No Platte	To Sidney	6900	2600	3000	2950	4650	3100	3400	3450	4200	3600	5150	6050	5600	5650	6650	4750	3300
Sidney	To Cheyenne	5350	2000	2350	2250	3600	2350	2600	2650	3250	2800	4000	4650	4300	4350	5150	3650	2550
Valley	To Valparaiso	3350	1250	1450	1450	2250	1450	1650	1700	2050	1750	2500	2950	2750	2750	3200	2300	1600
Valparaiso	To Lincoln	9700	3650	4250	4100	6550	4350	4750	4850	5900	5050	7250	8500	7850	7950	9350	6700	4700
Lincoln	To Beatrice	3950	1500	1750	1700	2650	1750	1950	2000	2400	2050	2950	3450	3200	3250	3800	2700	1900
Beatrice	To Marysville	6000	2250	2650	2550	4050	2700	2950	3000	3650	3150	4500	5250	4900	4950	5800	4150	2900
Julesburg	To LaSalle	9700	3650	4250	4100	6550	4350	4750	4850	5900	5050	7250	8500	7850	7950	9350	6700	4700
Cheyenne	To Archer	5350	2000	2350	2250	3600	2350	2600	2850	3250	2800	4000	4650	4300	4350	5150	3650	2550
Valley	To Co Bluffs	6900	2600	3000	2950	4850	3100	3400	3450	4200	3000	5150	6050	5600	5650	6650	4750	3300
Marysville	To Beatrice	8050	3050	3500	3400	5450	3600	3950	4050	4900	4200	6050	7050	6550	6600	7750	5600	3900
Beatrice	To Valparaiso	6900	2600	3000	2950	4650	3100	3400	3450	4200	3600	5150	6050	5600	5650	6650	4750	3300
Valparaiso	To Valley	3350	1250	1450	1450	2250	1450	1650	1700	2050	1750	2500	2950	2750	2750	3200	2300	1600
Cheyenne	To Buford	2700	1000	1200	1150	1800	1200	1350	1350	1650	1400	2050	2400	2200	2250	2600	1850	1300
Cheyenne	To Dale	4700	1750	2050	2000	3150	2050	2300	2350	2850	2450	3500	4100	3800	3850	4500	3200	2250

WY DIVISION

WYOMING DIVISION

WESTWARD			SECOND SUBDIVISION		EASTWARD		
STATION NUMBER	LENGTH OF SIDINGS FEET	FIRST CLASS 5 DAILY	Timetable No. 3 STATIONS		MILE POST	FIRST CLASS 6 DAILY	RULE 6(B)
510			DN-R CHEYENNE YL	TRACKS 1, 2	509 5		FPTXY
			1 3				
			WEST CHEYENNE YL		510 8		PX
			0 2				
			CP511		511 0		PX
			3 5				
515	900		WYCON (SPUR-E)		514 5		P
			4 4				
			CP519		518 9		PX
			0 2				
519	5164 1314	2 10PM	BORIE		519 1	A3 25PM	PX
			9 5				
529	4173		GRANITE		528 6		PX
			1 5				
			CP530		529 9		PX
			6 7				
537	C5852		BUFORD		536 6		P
			3 8				
540	1250		SHERMAN (SPUR-W)		540 4		PY
			2 6				
545	2171		DALE (SPUR-E)		543 0		P
			1 8				
			DALE JCT		544 8		PX
			2 5				
			CP547		547 3		PX
			0 6				
548			HERMOSA		547 9		PX
			0 7				
			CP549		548 6		PX
			5 4				
554	572		COLORES (SPUR-E)		554 0		P
			9 0				
563	519		FORELLE (SPUR-E)		563 0		P
			2 3				
			CP565		565 3		PX
			0 7				
566			DN-R LARAMIE		566 0		FPXY
548			HERMOSA	TRACK 3	B547 9		PX
			8 9				
557	5849		RED BUTTES		B556 8		P
			9 5				
566			DN-R LARAMIE		B566 3		FPXY
510			CTC-ACS DN-R CHEYENNE	TRACKS 3, 4	509 5		FPTXY
			9 5				
15-518	C6489		SPEER		519 0		PXY
			CP517	TRACK 3	517 2		PX
			1 1				
			CP518		518 3		PX
			0 7				
15-518	C6489		SPEER		519 0		PXY
			6 8				
15-526	6217		EMKAY		525 8		P
			8 4				
15-534	6408		LYNCH		534 2		P
			8 5				
15-543	6722		HARRIMAN		542 7		P
			6 8				
15-550	6134		PERKINS		549 5		P
			4 8				
			DALE JCT		554 3		PX
			CP565	TRACKS 1, 2	565 3		PX
			0 7				
566		s3 15	DN-R LARAMIE		566 0	s2 25	FPXY
			4 5				
			CP570		570 5		PX
			11 7				
			CP582		582 2		PX
			3 1				
585	C4301		BOSLER		585 3		P
			5 3				
590	753		COOPER LAKE (SPUR-E)		590 6		P
			3 3				
594	1585		LOOKOUT (SPUR-W)		593 9		PX
			7 1				
			CP601		601 0		PX
			4 3				
605	C5944		ROCK RIVER		605 3		PY
			3 7				
609			WILCOX		609 0		PX
			7 8				
			CP617		616 8		PX
			6 1				
623	C5985		D MEDICINE BOW		622 9		PY
			1 6				
			CP624		624 5		PX
			7 5				
			CP632		632 6		PX
			6 3				
639			RAMSEY		638 9		PX
			4 2				
642	11772		DN-R HANNA		643 1		PXY
			7 1				
			DURRANT		650 2		PX
			6 4				
657	403		EDSON (SPUR-W)		656 6		P
			5 6				
662			WALCOTT		662 2		PXY
			9 9				
672			BENTON		672 1		PX
			4 2				
876			SINCLAIR		676 3		P
			4 0				
			CP680		680 3		PX
			2 5				
683	11602 19126	A5 05PM	DN-R RAWLINS		682 8	12 30PM	FPXY

(VIA SHERMAN 173 3)
(VIA HARRIMAN 182 8)

Note 2 to Rule 99 is in effect on Second Subdivision

CLEARANCE AND REGISTER REQUIREMENTS

Clearance need not be received by trains entering or leaving Second Subdivision at Speer or Borie

Train movements on Medicine Bow and Energy Spurs must be authorized by train order Unless authorized by train dispatcher, eastward trains on Medicine Bow Spur must stop west of Energy Spur switch

Trains from Encampment Branch need not receive clearance at Walcott but must receive verbal authority from train dispatcher before occupying Second Subdivision tracks

Only trains which originate or terminate at Laramie or Hanna need register at Laramie or Hanna

On Coal Spurs, westward trains are defined as those trains moving to coal tipples and eastward trains as those trains moving from coal tipples

SPEED RESTRICTIONS — SECOND SUBDIVISION

LOCATION	MPH Psgr	MPH Frt
Between Mile Posts —		
Cheyenne		
509.1 and 510.0 until engine passes these locations	20	20
510.1 and 511.5	40	40
Reduce speed signs located North side No 1 track and South side No 4 track also apply to tracks 2 and 3		
Cheyenne yard		
Yard lead at east end	15	15
All yard leads at the west end	15	15
North 1, 2, 6 and 7 tracks	15	15
South 1, 2, 4 and 6 tracks	15	15
All other tracks	5	5
Maximum speeds between Cheyenne and Dale Junction No 1 and No 2 tracks	70	55
Maximum speeds between Dale Junction and East Laramie No 1 and No 2 tracks	40	40
All eastward trains with tonnage in excess of 100 tons per operative brake must not exceed 20 MPH on No 1 and No 2 tracks from MP 536 to Cheyenne and must not use less than the times shown below between the designated points		
MP 536.0 to MP 528.5 — 22 mins		
MP 528.5 to MP 519 1 — 28 mins		
MP 519.1 to MP 510.8 — 25 mins		
Important — For movement on descending grades see Special Rule 1042 (RW) page 146.		
Maximum speed on Borie Cut-Off between Speer and Borie	50	50
102 6 and 103.3	35	35
Maximum speed between Cheyenne and Dale Junction on No 3 track and between Cheyenne and Speer on No 4 track	60	55
Less than 100 tons per operative brake		
with operative dynamic brake		55
without operative dynamic brake		45
Maximum speed on No 3 track between Hermosa and Laramie B 548 7 and B 565.5*	70	60
Important — For movement on descending grades see Special Rule 1042 (RW) page 146.		
Maximum speed between Laramie and Rawlins	90	70
Laramie		
Tie yard lead between MP 565 6 and MP 565 85		10
Laramie Scale Track		
Live Scale Track		5
Between Scale House and MP 568 0		20
Between MP 568 0 and MP 569 3		30
Warehouse Tracks 2, 3, 4		5

*Note — Between West Hermosa and East Laramie via Red Buttes mile post numbers are prefixed with letter B

WY DIVISION

WYOMING DIVISION

SPECIAL RULES—ALL SUBDIVISIONS

Movement at Stations

96 (RW). At the following locations, yard engines and light engines may move between "A" signals and switching limit signs without clearance Form 2643 on signal indication and authority from train dispatcher

Location	Between Mile Posts
Cheyenne	506 25 and 511 81
Laramie	564 82 Track 1 or 563.59 Track 3 and 570 43
Rawlins	680.10 and 685 16
Rock Springs	800 8 and 804 0
Green River	814 15 and 818 49

Block Clearance

96 (RW-1). Train and engine movements on Jim Bridger Spur will be controlled by train dispatcher through issuance of block clearances, Form 2643 BC, via radio or phone to conductor and engineer of train to be moved All train and engine movements between Point of Rocks and Pacific Power and Light Plant must be authorized by block clearance and no portion of track between these points may be occupied unless conductor and engineer have a valid block clearance in their possession.

All block clearances must be copied by conductor and engineer and must be repeated by each of them to the train dispatcher and the repeated time given by train dispatcher must be entered, as well as name of person copying block clearance in spaces provided Train dispatcher must record block clearances in train order book in the following form, assigning a train order number to each, preceding it with the letters BC, thus.

BC 1

Point of Rocks to C&E Work Extra 201

This is your authority to occupy track between Point of Rocks and Prospect Point

Additional instructions — Do not exceed 20 MPH between MP 2 and MP 3

TAW

R 1247 PM Condr Jones
R 1248 PM Engr Smith
Reported clear at 215 PM

Proper receipt of block clearance by a train or engine is authority for movement from the first named station to the second named station only Protection of rear of train as prescribed by Rule 99 is not required in block clearance territory When train or engine authorized by block clearance has arrived in clear at destined station, conductor must report arrival to train dispatcher and enter the time reported clear on the block clearance No further movement between stations may be made without receipt of another block clearance

Additional instructions such as, "Do not exceed 10 MPH between MP 2 and MP 3," must be entered on block clearance as transmitted by the train dispatcher If no additional instructions, the word "NONE" must be entered Only one block clearance may be issued for a block at one time.

Dispatcher's transfer must include block clearances still in effect

Block clearance must not be issued until the preceding movement has reported clear of the track

96 (RW-2). All movements between Ramsey and East Switch are governed by signal indication.

Train and engine movements on Ramsey Spur will be controlled by train dispatcher through issuance of block clearances, Form 2643 BC, via radio or phone to conductor and engineer of train to be moved. All train and engine movements between East Switch and Carbon County must be authorized by block clearance and no portion of track between these points may be occupied unless conductor and engineer have a valid block clearance in their possession.

All block clearances must be copied by conductor and engineer and must be repeated by each of them to the train dispatcher and the repeated time given by train dispatcher must be entered, as well as name of person copying block clearance in spaces provided Train dispatcher must record block clearances in train order book in the following form, assigning a train order number to each, preceding it with the letters BC, thus:

BC 1

Ramsey to C&E Extra 201 West

This is your authority to occupy track between East Switch and Carbon County

Additional instructions — Do not exceed 20 MPH between MP 2 and MP 3 on Arch siding

TAW

R 1247 PM Condr Jones
R 1248 PM Engr Smith
Reported clear at 215 PM

Proper receipt of block clearance by a train or engine is authority for movement from the first named station to the second named station only Protection of rear of train as prescribed by Rule 99 is not required in block clearance territory

Additional instructions such as, "Do not exceed 10 MPH between MP 2 and MP 3, Arch Siding" must be entered on block clearance as transmitted by the train dispatcher If no additional instructions, the word "NONE" must be entered Only one block clearance may be issued for a block at one time.

Conductor or engineer must report to train dispatcher when clear of locations listed on block clearance and must enter time reported clear at destined station on block clearance form. No further movements between stations may be made without receipt of another block clearance.

All eastward movements must communicate with train dispatcher before departing East Switch Movements to Rosebud and Carbon County must remain clear of west end of Arch siding and Main track unless block clearance states otherwise

Block clearance must not be issued until the preceding movement has reported clear of the track

Dispatcher's transfer must include all block clearances still in effect

Air Brake Rules

1030 (RW). At Rawlins, air brake rule 1030 (C) is in effect.

Retaining Valves

1042 (RW). The tables on page 148 govern operation of freight trains and use of retaining valves, in territories shown. This does not modify the requirements of Air Brake Rule 1042:

1. Dynamic brake must be placed in operation and tested at a convenient location prior to reaching designated descending grades.
2. When use of retaining valves is required, these valves must be placed in "HEAVY HOLDING" position on all cars in train.
3. On branch lines, retaining valves must be used on all cars in train descending grades 1.50% or more unless handled by locomotive with effective dynamic brake on units providing not less than one horsepower per trailing ton.

MofW Block Clearance

1500 (RW). Movement of MofW equipment or work to be performed by MofW forces on Ramsey Spur and Jim Bridger Spur will be controlled by train dispatcher through issuance of block clearances, Form 2643 BC, via radio or phone to MofW foreman or supervisor in charge of work or movement to be made.

Movement of track motor cars, MofW equipment, or MofW work to be performed on either spur may be authorized by block clearance and no portion of track on either spur is to be occupied unless MofW foreman or supervisor in charge has a valid block clearance in his possession

Block clearance must be copied by foreman or supervisor in charge and must be repeated by him to the train dispatcher and the repeated time given by train dispatcher must be entered in the space provided as well as name of person copying block clearance. Train dispatcher will record block clearance in train order book in the following form, assigning a train order number to each, preceding it with the letters BC, thus.

BC 2

Ramsey (Point of Rocks) to Foreman A B Smith

This is your authority to occupy track between East Switch (Prospect Point MP 6 58) and Rosebud (Pacific Power & Light)

Additional instructions — Men and machines must be clear of track at 215 PM

TAW

R 1250 PM by Foreman Smith
Reported clear at 210 PM

Proper receipt of block clearance by Mof W foreman or supervisor is authority to occupy track between stations named only Protection as prescribed by MofW Rule 99(E) is not required when foreman or supervisor possesses a valid block clearance in block clearance territory

Additional instructions will specify when all MofW men and machines must be clear of track and must be entered on block clearance as transmitted by train dispatcher

Prior to the time specified in additional instructions, all men and machines must be clear of track ready for movement of trains Foreman or supervisor who was issued the block clearance must observe that all equipment is in the clear and notify all personnel that the track is to be released, and must report to train dispatcher time track cleared and ready for movement of trains, and enter the time reported clear on block clearance. No further work may be performed or movement made on track without receipt of another block clearance

Train dispatcher must not permit a train or engine to enter a block occupied by MofW forces holding a valid block clearance. Block clearance for a train waiting to move must not be issued until MofW foreman or supervisor who was issued the block clearance has reported men and machines are clear of the track and the track is ready for movement of trains.

* * *

SPECIAL RULES—SECOND SUBDIVISION and BRANCHES

Signal Indications

241 (RW). At Hanna, westward movement on Coal Spur MP 2.0 will be governed by three-unit Stop signal as follows:

Westward signal aspect displayed for a straight track movement to Energy Spur will be a green over red over red with a dark (E) Indicator If this track is lined for Medicine Bow Spur, indication will be a red over red over red with illuminated (E) Indicator. Operating Rule 241-A governs. After train has stopped, lined the switch for Energy Spur, the illuminated (E) will go out and a green over red over red aspect will be received.

With the dispatcher requesting move to the Medicine Bow Track, with the switch properly lined, the westward signal aspect will be red over red over green to go through the No. 10 turnout with a dark (MB) Indicator If the switch is not lined for Medicine Bow Track, a red over red over red with illuminated (MB) Indicator will be displayed Operating Rule 241-A governs. After switch is lined for the turnout the switch aspect will change to a red over red over green with (MB) Indicator darkened.

End of the block signs will be located at MP 2.0 on Energy and Medicine Bow Tracks.

267 (RW). At Durrant, when signal governing movement to Arch Mineral Spur No. 1 and at Ramsey, when signal governing movement to Arch Mineral Spur No. 2 display proceed indication, movement is authorized on spur in either direction without flag protection.

If signal fails to display proceed indication, movement on spur must be authorized by Form C Clearance, which must be copied by a member of crew, repeated to train dispatcher and delivered to engineer.

Weigh-In-Motion Scale

804 (RW). At Laramie, weigh-in-motion scale is located un yard track No. 1. Lights located on north side of track govern movement approaching scale and when weighing cars and display the following indications:

Green-	Moving at proper speed.
Flashing yellow-	Caution, approaching maximum weighing speed.
Red-	Unless otherwise instructed, stop movement, back train up and start weighing operation again.

Speed of 5 MPH must not be exceeded while weighing over scale. Wheels on units must not be allowed to slip or slide while on scale.

Air Brake Rules

1029 (RW-1). On passenger trains, running air test as required by Air Brake Rule 1029 must be made at Sherman, by eastward and westward trains, and at Speer by eastward trains.

APPENDIX E

EXCERPTS FROM UNION PACIFIC RULES AND INSTRUCTIONS GOVERNING OPERATION OF AIR BRAKES

BRAKING FREIGHT TRAINS

1038. When making a service stop or reducing speed of a freight train, initial brake pipe reduction must be made, after which, sufficient time must be allowed for proper adjustment of slack in train before further brake pipe reduction is made to required amount. After initial brake pipe reduciton is made, throttle must be reduced gradually as speed of train reduces. When train has reached point where it is evident it will stop within the next forty (40) feet, a further brake pipe reduction must be made of sufficient amount to have air exhausting from automatic brake valve, throttle must be closed, rails sanded, and independent brake fully applied on all locomotives on head end as train comes to stop.

DYNAMIC BRAKING

1039. When starting use of dynamic brake, wait 10 seconds before moving selector lever to "OFF" position and wait 10 seconds before moving from "OFF" to "B" position. When going to power operation from dynamic braking, wait 10 seconds before moving selector lever from "B" to "OFF" position, and wait 10 seconds before moving from "OFF" to throttle 1 position. In order to avoid excessive current surges, selector lever must be moved slowly into and out of dynamic braking ranges. When dynamic brake is first applied, extreme care must be used to avoid rough handling of train.

1039(A). Dynamic brake must be supplemented by use of train air brakes to extent necessary to properly control speed of train.

1039(B). Under no circumstances must locomotive air brake be allowed to apply when dynamic brake is in use, except when making stop, and brake cylinder gauge on locomotive must be frequently observed to insure that locomotive air brake is kept released.

1039(C). Load indicating meter and warning light or buzzer must be closely observed during time dynamic brake is in use to avoid excessive braking force which would result in damage to traction motors and grids. Engineer must not permit use of current in excess of maximum permissible and must be governed by first indication of reaching maximum as indicated by either load indicating meter, warning light or warning buzzer.

1039(D). Under no circumstances may the dynamic brake warning light be covered with paper cups, cloth or any other material.

1039(E). When stopping freight train with dynamic brake in use, dynamic brake operating lever must be moved to "OFF" position immediately when train comes to a stop and independent brake applied slowly to prevent slack from running out.

1039(F). When a unit in the consist is to be isolated, unit must be out of dynamic braking before isolating.

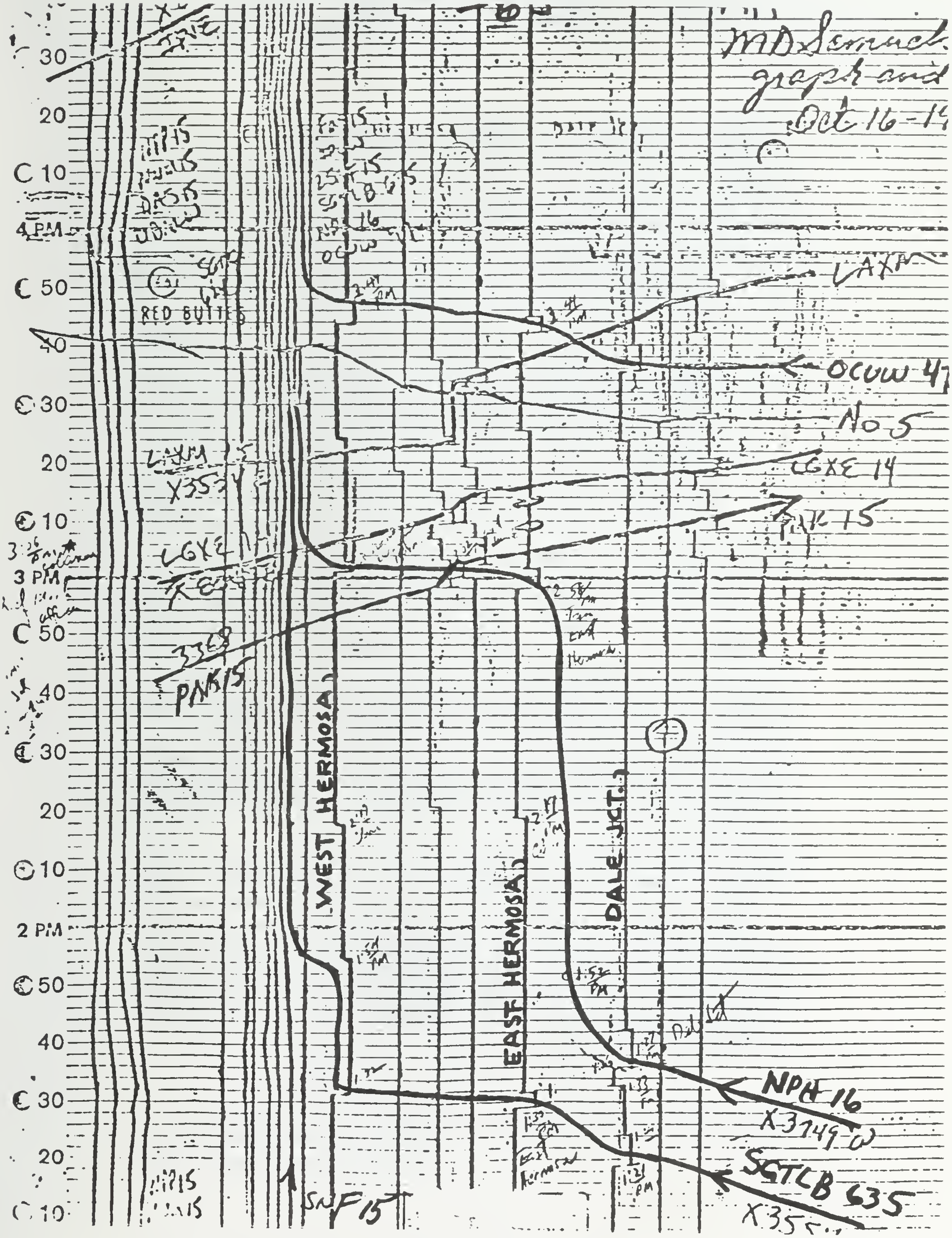
1039(G). If dynamic brake is inoperative on any unit of multiple unit locomotive, the unit selector switch must not be changed unless defective unit is set out.

1039(H). If dynamic brake warning light comes on or buzzer sounds immediately after placing transition lever in braking zone, lever must be promptly removed from braking zone and dynamic brake must not be used.

1039(I). On descending grades, when handling freight trains having light loads or empties on head end and heavy loads on rear end, not more than one-half of maximum dynamic brake may be used while such head end cars are passing through turn-out or cross-over where speed is 30 M.P.H. or less. Speed of train must be controlled by application of air brakes as necessary, and use of maximum dynamic brake must not be permitted until after all such head end cars have passed through turn-out or cross-over.

APPENDIX F

EXCERPTS FROM TRAIN DISPATCHER'S TRAIN GRAPH



APPENDIX G

EXCERPTS FROM MANAGEMENT OF TRAIN OPERATION AND TRAIN HANDLING (REPRINTED WITH PERMISSION OF THE AIR BRAKE ASSOCIATION)

K. Pressure Maintaining and Dynamic Brake Operation

a. This is the most common combination of braking on grades.

b. When the train is going over the apex (top) or crest of a grade, it is optional to use either the train air brake or dynamic brake first.

   1. With short light trains, it is the general practice to apply the dynamic brake first. If necessary, the train air brake is added as a supplement to control train speed.

   2. With heavy trains, it is preferable to apply the train air brake first. The brake pipe reduction should not be started until the throttle has been reduced to idle and train speed starts to increase. Start the air brake application so that all car brakes will be applied as the rear end passes over the summit. This will allow brake shoes and wheels to warm up to provide effective retardation. The dynamic should be then applied as required to assist in controling speed. The total brake pipe reduction should be slightly less than that required to handle the train with air alone, so that dynamic can be varied to regulate train speed with dynamic help.

c. Depending upon particular grade conditions, try to make the air brake application of such degree that the train will keep rolling (will not stall) through curves and lesser grade portions of the area. Vary the dynamic to control speed on other sections of the grade.

d. Plan brake operation so that maximum or heavy dynamic is not used when rounding sharp curves. Be careful when going through turnouts and switches that too much dynamic is not used.

e. If dynamic brake helpers are used in the train, they should not use dynamic until actually close to the crest or on the descending grade. If too much helper dynamic is applied too soon, severe slack action may result.

f. On grades where a large portion of the retarding force is provided by the dynamic brake, prompt action is imperative if all or a part of the dynamic suddenly becomes inoperative. If this situation arises, probably evidenced by a severe slack-run, loss of dynamic brake amperage, etc., safe practice is to get the train stopped quickly. On heavy grades, speed can get out of control in a very short time, use emergency application without hesitating. Service applications usually react too slowly and allow too much speed increase while they are becoming effective.

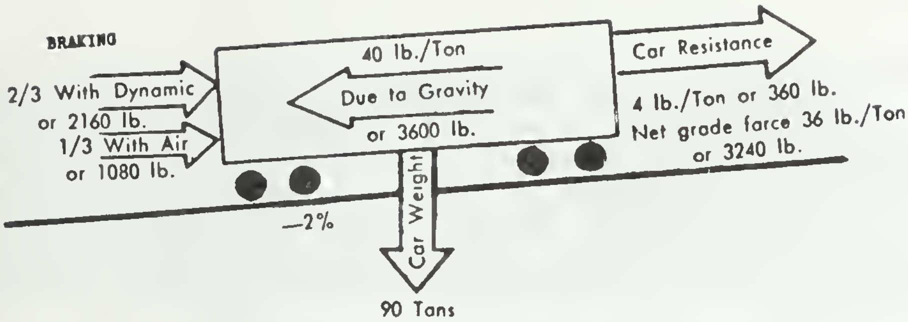


FIG. 117 RELATIONSHIP OF AIR AND DYNAMIC BRAKE

In the example above, Fig. 117 a 90-ton car moving down a 2% grade is under sufficient braking force to balance the pull of gravity downgrade. If 1/3 the braking force is due to the air brake and 2/3 from dynamic brake, and the dynamic brake fails, the car will be subject to an accelerating force due to gravity of 2160 lb. This will cause speed to increase at about .24 mphps. After one minute the car speed will have increased about 14 mph. This situation becomes much more critical with heavier cars on steeper grades.

Even if the addition of 10 psi more brake pipe reduction would eventually balance the grade, at the higher speed, the brake horsepower may be high enough to be excessive for a long grade. Both brake shoes and wheels will probably be overworked.

Again, if dynamic is lost or becomes overworked and ineffective for any reason on a heavy grade:

1. Get the train stopped quickly.
2. Use emergency application.
3. Follow safe practice and local rules before proceeding after such an unplanned stop on the grade.

* * *

SECTION 7. DYNAMIC BRAKING SYSTEM

Dynamic braking is an electrical arrangement used to change some of the mechanical power developed by the momentum and downhill force of a moving train into electrical power. The electrical power is converted into heat which is blown out through a hatch at the top of the locomotive.

Traction motor armatures, being geared to the axles, rotate whenever the locomotive is moving. During dynamic braking the motors become electrical generators, and the electrical output of the motor armatures is connected across fan cooled resistor grids of fixed ohmic value. Armature output is determined by the speed at which the armatures rotate (track speed) and by the amount of excitation current flowing in the motor fields (stationary coils).

Excitation current in the motor fields is controlled by braking lever (throttle) position and by a regulating device. This device, the dynamic brake regulator DBR, senses voltage across one-half a braking grid, interprets it as armature/grid current, and operates to reduce field current in order to hold armature current (and grid voltage) at the maximum permitted by equipment design. It does this whenever maximum current level is attained, regardless of braking lever (throttle) position.

The graph in Fig. 149 shows that with maximum traction motor field current (braking lever in position 8), braking effort increases as track speed increases from zero to about 25 mph. Thereafter, braking effort lessens as track speed increases.

Braking effort may be considered as negative tractive effort or "drawbar push." This effort can be interpreted as weight, with both grade force and the momentum of the moving train going to make up what is being called weight. The weight by itself performs no function; it merely has the ability to perform useful work. During dynamic braking the use of the work is to maintain train speed or to slow down a train. This work results in heat at the dynamic braking grids rather than at brake shoes.

To understand the term "braking effort," consider the terms:

1. Mass or weight.
2. Work—the energy required to lift the weight a given distance.
3. Power—the energy required to lift the weight a given distance in a given amount of time. For example, a very small output of energy can lift a tremendous weight if given sufficient time.

Fig. 149 indicates that braking effort falls off as train speed increases above the optimum. This is so because of design limitations in the equipment involved. Theoretically, braking effort could increase along the dash-dotted line extending to the top of the graph, but regulation occurs to protect the equipment.

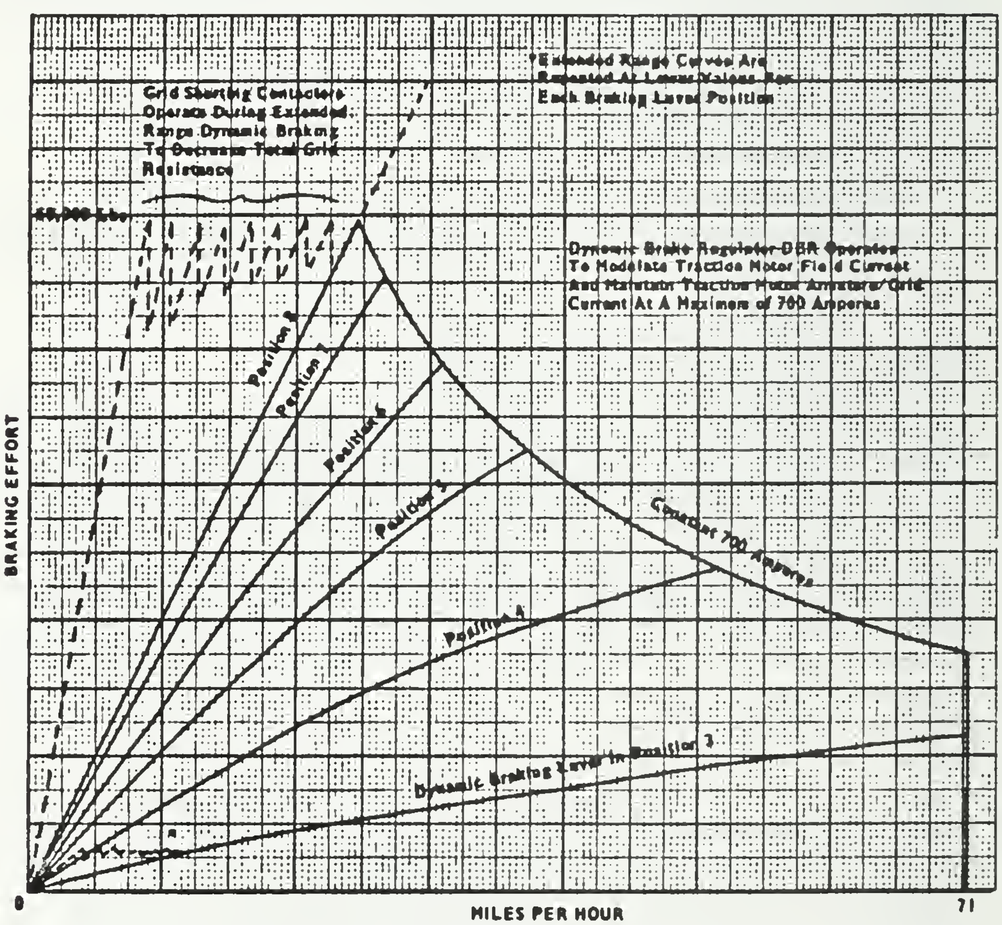


FIG. 149 DYNAMIC BRAKING CURVES—62:15 GEARING
BRAKING EFFORT/MILES PER HOUR

To determine why braking effort does not remain at the maximum value, but falls with increased track speed, note the following:

1. At maximum braking lever position, grid voltage and current are regulated and constant above approximately 25 mph; consequently the power (volts × amperes) dissipated as heat is constant.
2. Power, electrically expressed as volts × amperes, may also be expressed as foot pounds per second or, in railroad terms, ton miles per hour.

$$1 \text{ Horsepower} = \frac{375 \text{ pound miles}}{\text{hour}}$$

Since design limitations require that the current in the dynamic braking resistors does not exceed maximum, an increase in the speed factor (miles/hours) of the horsepower formula must be accompanied by a decrease in the weight factor (pounds) of the formula in order to maintain the maximum current limitation. This weight factor is reduced by decreasing the retarding force of the traction motor fields.

In other words, a decrease in the magnetic flux induced by motor field current, brings about a reduction of the resistance to the turning of the motor armature. Less effort is required to turn the armature, but since it turns faster at higher track speed, the resulting power remains the same while braking effort decreases.

EXTENDED RANGE DYNAMIC BRAKES

Below optimum speed of about 25 mph, braking effort declines. This is because the voltage developed by the motor armatures falls below maximum even though motor field excitation is at its upper limit.

By Ohm's law $$I = \frac{E}{R} \text{ or}$$

$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

It can be seen that when voltage drops, current can be maintained at a high level only by reducing grid resistance. The extended range dynamic braking system reduces grid resistance in steps as track speed decreases.

In the extended range dynamic braking system all resistor grids are connected in series with all motor armatures. Cables carrying dynamic braking current pass through the frames of two transductors, and coils carrying AC from the D14 alternator are wound on the cores of the transductors. The impedance of these coils is controlled by the amount of current passing in cables through the transductor frames. The output from the AC coils passes through the primary windings of transformers and is transformed to a usable value. The output from the transformers is rectified and loaded upon resistors and potentiometers.

Voltage signals that are in direct proportion to the current in the dynamic braking cables are taken from the brush arms of the potentiometers and directed to sensitive polarized relays. The relays match the signals against throttle controlled signals and function to control stepping of a motor operated program switch that in turn controls pickup of power contactors. The power contactors, located in a hatch adjacent to the grids, close singly and in combination to short out portions of the total dynamic braking grid resistance and thus maintain maximum braking current down to very slow speed.

On SD type locomotives dynamic braking current also passes through the frame of a voltage operated current biased relay OCP that picks up to disable the dynamic braking system if an open resistor grid results in voltage at the relay coil but no current in the system.

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RAILROAD ACCIDENT REPORT

HEAD-END COLLISION OF AMTRAK PASSENGER TRAIN NO. 74 AND CONRAIL TRAIN OPSE-7 DOBBS FERRY, NEW YORK NOVEMBER 7, 1980

NTSB-RAR-81-4

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes

The subject report was distributed to NTSB mailing lists: 8A, 8D, 14A and 14B.

16. Abstract

About 4:12 p.m., on November 7, 1980, Conrail freight train OPSE-7 struck the head-end of Amtrak train No. 74 while it was standing on track No. 2 at Dobbs Ferry, New York. The lead locomotive unit of train OPSE-7 overrode and destroyed the operating cab of the power car of train No. 74. Of the estimated 234 persons aboard the trains, 75 passengers and 9 crewmembers were injured. Damage to the equipment was estimated at $915,000.

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the OW operator to apply a blocking device to the signal lever which permitted him to clear the signal and allowed train No. 74 to proceed on an occupied track, and Conrail's condoning the transmission of train orders without requiring the operator to display the train order signal. Contributing to the accident were the improper training and inadequate supervision of the operator and the failure of Conrail to provide a reasonable means of displaying train order signals at OW. Contributing to the injuries were the design of the seats and lack of emergency evacuation instructions.

17. Key Words	18. Distribution Statement
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: April 28, 1981

HEAD-END COLLISION OF AMTRAK PASSENGER TRAIN NO. 74 AND CONRAIL TRAIN OPSE-7, DOBBS FERRY, NEW YORK NOVEMBER 7, 1980

SYNOPSIS

About 4:12 p.m., on November 7, 1980, Conrail freight train OPSE-7 struck the head end of Amtrak train No. 74 while it was standing on track No. 2 at Dobbs Ferry, New York. The lead locomotive unit of train OPSE-7 overrode and destroyed the operating cab of the power car of train No. 74. Of the estimated 234 persons aboard the trains, 75 passengers and 9 crewmembers were injured. Damage to the equipment was estimated at $915,000.

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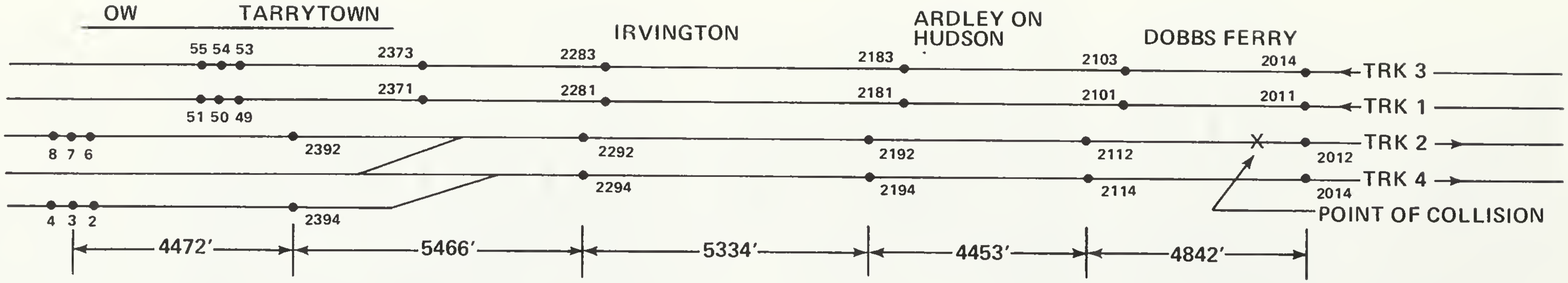
INVESTIGATION

The Accident

At 12:30 p.m. on November 7, 1980, westbound Conrail Freight Train Extra 2806 (OPSE-7), consisting of 3 locomotive units, 120 cars, and a caboose, departed the Oak Point Yard, Bronx, New York. At 1:24 p.m., the train entered the Conrail metropolitan region, Hudson Line, at the Melrose (MO) interlocking station. (See figure 1.) At this point, the train came under the direction of the lower Hudson Line train dispatcher. The train continued westward on track No. 1 and approached Spuyten Duyvil (DV) interlocking station at approximately 2:50 p.m. The train dispatchers at Grand Central Terminal, New York City, were changing shifts at the time, and the oncoming dispatcher was notified by the upper Hudson Line train dispatcher that he was not able to take OPSE-7 on the upper Hudson Line because he had two tracks out of service. Work was being performed on track No. 1, and track No. 4 was being used by the track department to unload material. Serious delays to the evening commuter rush hour trains would have developed had the long, slow moving freight train been allowed to continue westward. Confronted with this problem, the lower Hudson Line dispatcher decided to allow OPSE-7 to continue westward on track No. 1 as far as Glenwood, New York, where a remote interlocking controlled by DV was located; back it over from westward track No. 1 to eastward track No. 2; issue a



DISTANCE BETWEEN SIGNALS

STATION	MILEPOST
NEW YORK (GCT)	0
5.4	
MO TOWER	5.4
5.8	
SPUYTEN DUYVIL (DV)	11.2
5.1	
GLENWOOD	16.3
4.5	
DOBBS FERRY	20.8
3.9	
OW TOWER	24.7
0.6	
TARRYTOWN	25.3
8.1	
CROTON-HARMON	33.4

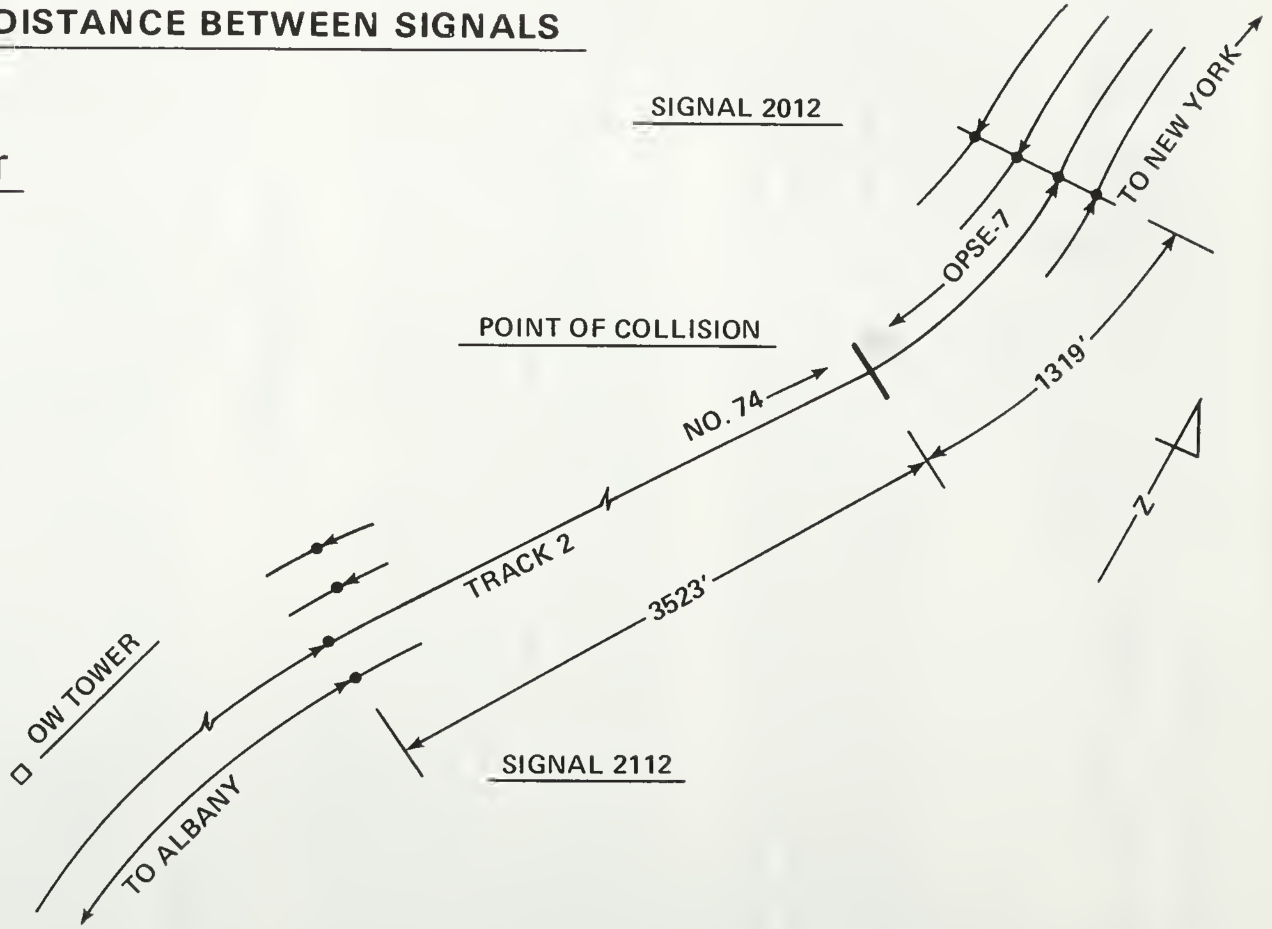


Figure 1.—Sketch of track alignment.

train order to run OPSE-7 westward against the current of traffic on track No. 2, by train order, to the OW interlocking station at Tarrytown, New York; and hold it at OW until the upper Hudson Line dispatcher could take the train when it would not delay the westbound commuter trains.

OPSE-7 arrived at Glenwood at 3:20 p.m. and had completed backing onto track No. 2 at 3:42 p.m. After talking with the operators at the DV and OW interlocking stations, the dispatcher determined that there were no trains between OW and Glenwood on track No. 2. (See appendix C.) The dispatcher instructed the OW operator to apply a blocking device for track No. 2 east. The OW operator did not apply the blocking device, but he replied "BDA (blocking device applied) signal 6 1/ at 3:49." Even though the operator did not indicate train order signal displayed, the train dispatcher issued train order No. 304, a "J" order 2/ to the OW operator:

> Hold all eastward trains clear of No. 2 track between OW and Glenwood.

The OW operator copied the order and repeated it to the dispatcher. The order was "made complete" 3/ at 3:50 p.m.

The dispatcher then issued train order No. 305 to the OW operator, the DV operator, and the conductor and the engineer of Extra 2806 (OPSE-7) in care of the DV operator:

> Extra 2806 West has right over opposing trains on No. 2 track Glenwood to OW.

Both operators copied and repeated the order, and the order was made complete at 3:54 p.m. The OW operator confirmed to the dispatcher that the block between Glenwood and OW was clear of any trains. The DV operator transmitted order No. 305 over Conrail radio channel No. 2 to the engineer of OPSE-7. The engineer repeated the order and it was made complete at 3:57 p.m. The DV operator reported that OPSE-7 departed Glenwood westbound on track No. 2 at 4:08 p.m.

As westbound OPSE-7 rounded a 0°54' curve approaching Dobbs Ferry, New York, about 4:12 p.m., the engineer and head brakeman saw a train approaching in the distance. At the first sighting of the train, the engineer and head brakeman said they were not able to determine which track the train was on because of the curve; but they thought that it was on another track. However, as OPSE-7 continued around the curve, the engineer and head brakeman saw that the train was on the same track. The engineer said he immediately applied the train brakes in emergency and the train started slowing from 38 mph. When it became evident that a collision would occur, the engineer and head brakeman laid on the locomotive cab floor.

At 3:56 p.m., eastbound Amtrak passenger train No. 74, the Empire State Express, consisting of a power club car, a food service car, three coach cars, and a power car, departed Croton-Harmon Station on track No. 2. At this time, the engineer switched, as required, from channel 2 to channel 3 because his train was now entering the commuter district.

1/ Controls the straight eastward movement on track No. 2.
2/ A J Order is issued to the operator for the purpose of holding a train.
3/ When an order has been repeated correctly by an operator, the response "complete" and the time, with the initials of the superintendent, will be given by the train dispatcher. The operator receiving this response will then write the word "complete," followed by the time and his last name in full.

As train No. 74 approached the OW interlocking, the engineer saw a red (stop) signal indication. The engineer, using the Metro Region Commuter Radio channel No. 3, called, "74 to OW," twice between 4:05 and 4:06 p.m. After the second call, the OW operator replied, "OK 74," and activated the signal lever, which cleared the signal for the train to continue east of OW on track No. 2. The OW operator recorded movement of train No. 74 east on track No. 2 at 4:08 p.m.

Train No. 74 continued eastward on track No. 2 in response to clear indications on the next three signals. However, the fourth signal, just west of Dobbs Ferry station, indicated "Advance Approach." However, before train No. 74 arrived at the signal, it changed to "Approach." The engineer reduced the train's speed to approximately 25 mph as it passed the signal and entered a 0°46' right-hand curve. On exiting the curve, the engineer and fireman saw a freight train about 0.5 mile to the east approaching on one of the four tracks. When the engineer determined that the approaching train was on the same track, he shouted a warning to the fireman and simultaneously applied the train brakes in emergency. The engineer and fireman jumped from the locomotive, without alerting the conductor or passengers, just before the train came to a stop.

Moments later, OPSE-7 collided with standing train No. 74 at about 10 mph. The impact derailed the lead unit of OPSE-7 and pushed train No. 74 rearward about 112 feet, derailing the lead power car (see figure 2) and the following three passenger cars. (See figure 3.) Electrical power to the four tracks was shut off after a crewmember boarded the cab of the rear power car and used the radio to request that the power be shut off because of the collision and because passengers were getting onto the tracks. An employee of a restaurant adjacent to the accident site immediately called the Dobbs Ferry Police Department. Within 3 minutes after the accident, emergency forces began to arrive at the accident site.

Injuries to Persons

Injuries	OPSE-7 Crewmembers	Train No. 74 Crewmembers	Passengers	Total
Fatal	0	0	0	0
Nonfatal	4	5	75	84
None	0	0	150*	150*
Total	4	5	225*	234*

* Estimated because a number of uninjured passengers left the scene of the accident before a total count could be obtained.

Damage

Damage to OPSE-7 was limited to the derailed lead locomotive unit. The front end coupler was broken and the front deck, handrails, and side steps were bent, torn, and twisted. The short hood was forward and it was crushed inward.

The operating cab of the power club car of train No. 74 was destroyed because of the 10-mph impact. All floor or deck mounted equipment was torn or sheared off. The other cars in the train sustained minor structural damage.

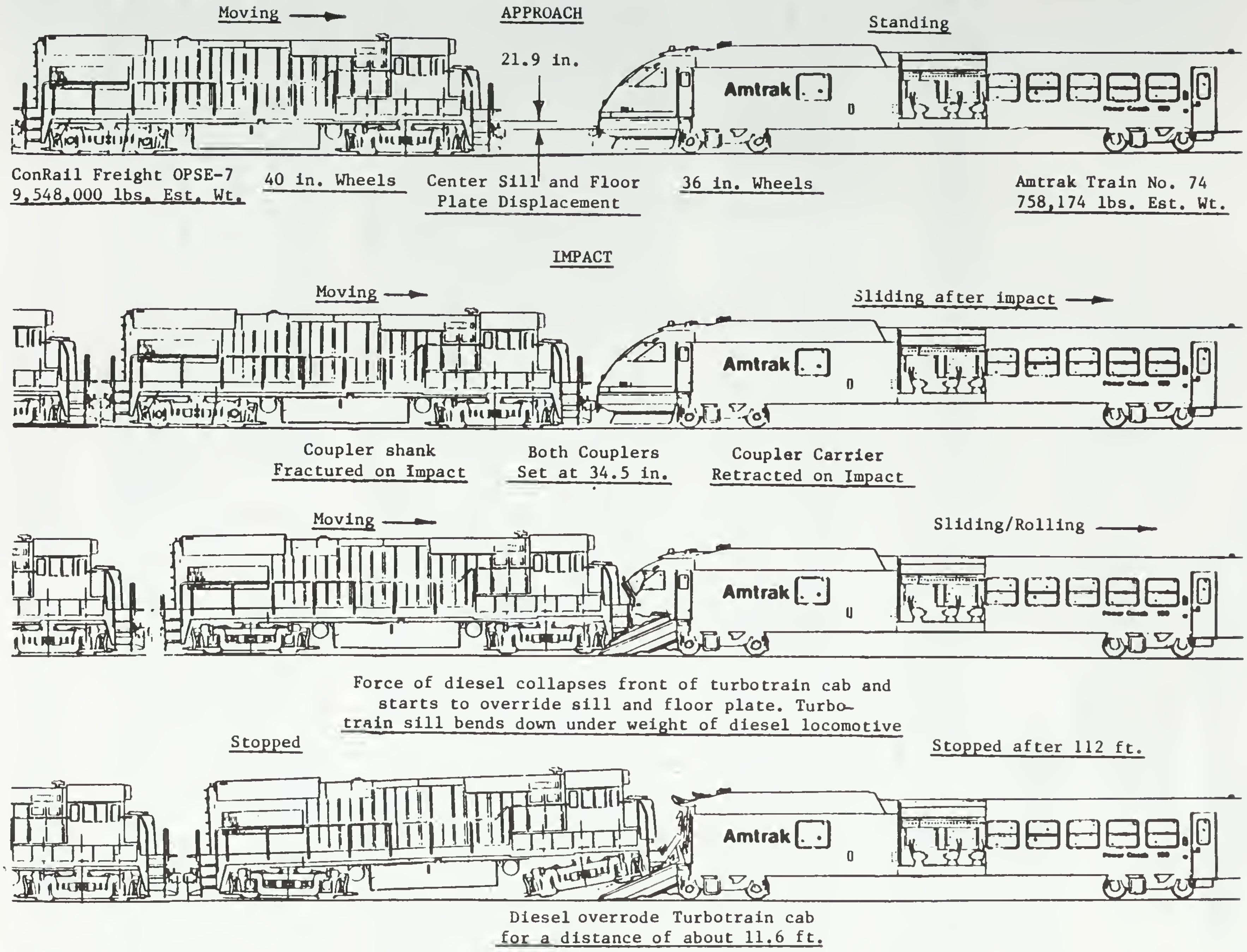


Figure 2.—Diagram of impact of OPSE-7 and No. 74.

Track damage was confined to the area of the collision and the 112 feet No. 74 was pushed rearward. The third rail equipment 4/ was also damaged when the second car of train No. 74 derailed and came to rest against it.

Damage was estimated as follows:

Equipment	$900,000
Track	10,000
Wreckage and cleanup	5,000
Total	$915,000

Crewmember Information

The crew of Conrail OPSE-7 consisted of an engineer, a conductor, and two trainmen. All were qualified under Conrail operating rules without restrictions. They had reported for work at Oak Point Yard, Bronx, New York, at 10:30 a.m., and had been on duty about 6 hours. (See appendix B.)

The crew of Amtrak train No. 74 consisted of an engineer, a fireman, a conductor, and two trainmen. All were Conrail employees and were qualified under Conrail operating rules without restrictions. The engineer and fireman had reported for work at Harmon at 2:55 p.m., and had been on duty approximately 1 hour 30 minutes. The conductor and two trainmen had reported for work at Albany, New York, about 1:05 p.m., and had been on duty about 3 hours 15 minutes. (See appendix B.)

The train dispatcher was qualified under Conrail operating rules without restrictions. He had been on duty about 1 hour 30 minutes. He had worked for Conrail for 4 years 6 months and had been a dispatcher for 1 year 6 months. Before becoming a dispatcher, he had worked as an operator. During his employment as an operator, he attended a 2-week school for operators in Wilmington, Delaware. He had 2 months on-the-job dispatcher training, which included operating rules classes, train order classes, and observing dispatchers responsible for three separate districts. After the accident, he stated that he had not required the operator to respond "stop signal and train order signal displayed" as required by Conrail rules for issuing a "J" order because, "it was never a practice in our office because the facilities for displaying a train order signal does not exist in most towers." He further stated that when he was an operator he had received train orders but did not display a train order signal because the facilities did not exist.

The OW operator was qualified under Conrail operating rules without restrictions. He had been on duty about 1 hour 15 minutes. After the accident, the OW operator stated he did not apply the blocking device. He further stated, "that is something you do automatically. You say 'BDA' and then go over and do it. This was the way I was trained." He had been working for Conrail for 1 year and 22 days. He had received on-the-job training with various operators on duty for 57 days and had worked on all three shifts. Before beginning the on-the-job training, he had attended 4 days of classroom instruction on the Conrail Rules of the Transportation Department. Before completing the on-the-job training, he successfully passed a written examination on the Rules of the

4/ A sliding contact shoe attached to the car truck of the electric equipment which collects current from the rail located alongside the running rail.

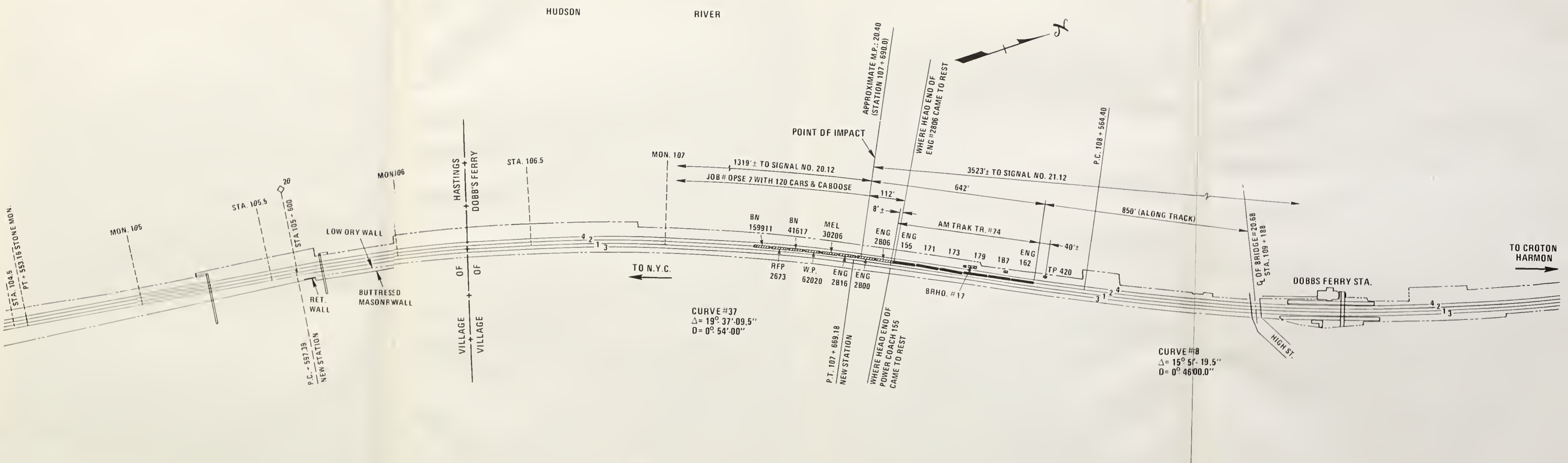


Figure 3.--DOBBS FERRY ACCIDENT SITE.

Transportation Department. He did not attend the 2-week school for operators at Wilmington because the school, which had been established by Conrail's predecessor company, Penn Central, and the 10-day program were eliminated during March 1977. During his employment, he had worked most of his time at OW; however, he had worked at White Plains for about 1 month and had been back at OW for 2 weeks before the accident. (See appendix B.)

Examination of the efficiency tests conducted on the dispatcher indicated that on June 12, 1980, the dispatcher had been observed and a record was prepared of the observation as he transmitted a train order. The report indicated that he complied with the Conrail rules for the transmission of train orders. There was no record of any observation of the performance of the OW operator.

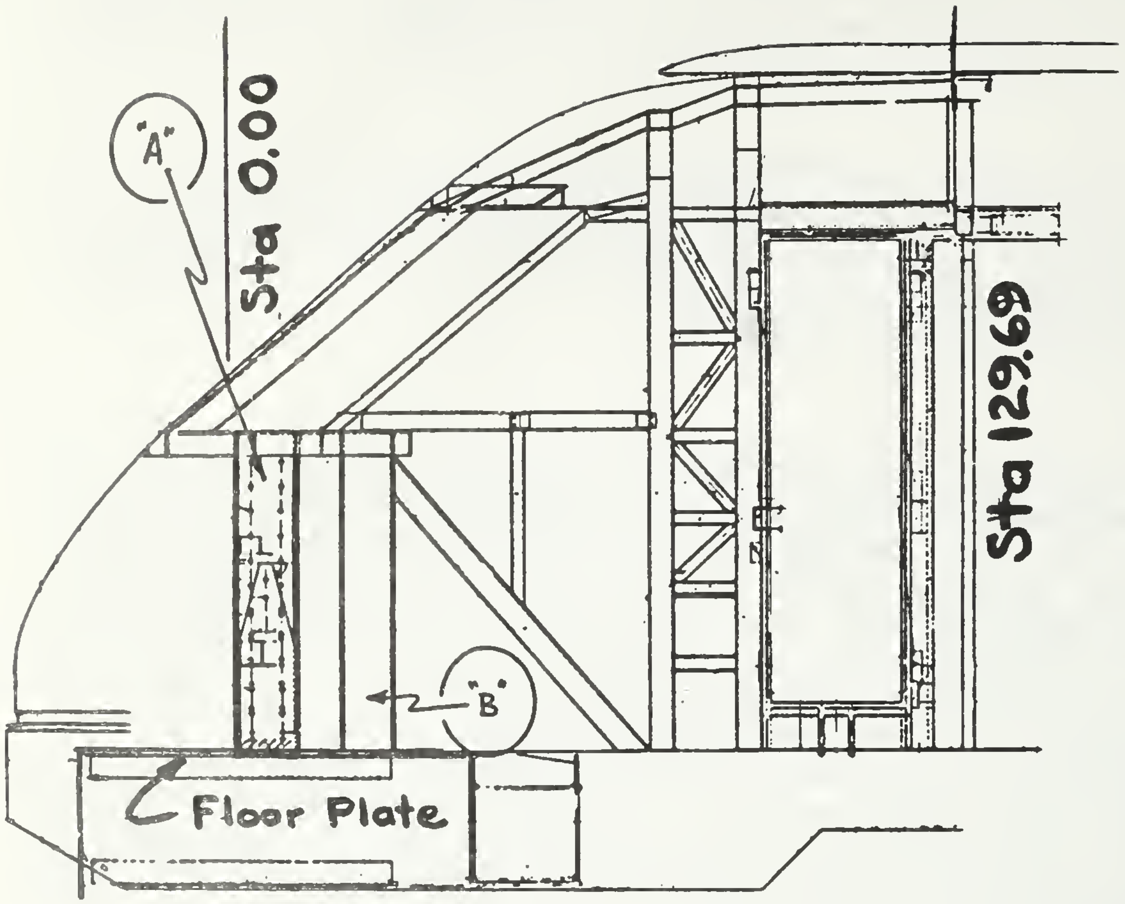
Train Information

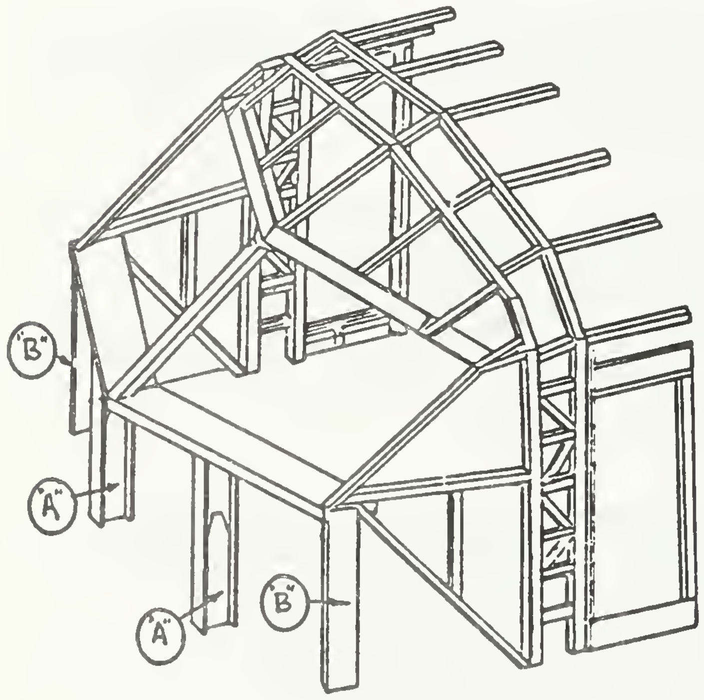
Train No. 74.--Train No. 74 had been inspected and its brakes tested before leaving Niagara Falls. No exceptions were taken during the inspection and tests. The train equipment was built by the Rohr Corporation and was model Rohr turboliner (RTL) Turbotrain equipment, an American version of the (ANF) built turbotrain which is operated by the French National Railway. The major difference between the two models, other than slight exterior appearance and interior equipment, is the ability of the RTL equipment to operate in the third-rail electric propulsion territory. This function is accomplished by the addition of four third-rail current collectors mounted on the truck side frames of each power car and various controls which provide electric power to a 150-hp electric traction motor in each power car. The motor is connected through an overrunning clutch to a hydraulic transmission which, in turn, is connected to axle-mounted gear boxes. When operating on third-rail electric propulsion, the main traction turbine engine is shut down and propulsion power is provided only by the electric traction motors.

All the cars of the turboliner including the power cars were of all steel construction and designed to comply with Association of American Railroads (AAR) specifications Nos. C-75 through -82 for the construction of new passenger cars to be used in trains having a total empty weight of 600,000 pounds or more.

The operating cab of the power car had two 10-inch I-beam forward posts, identified by Amtrak as collision posts, (see figure 4 item "A"), welded to the floor. One end of the angled supports (item "B") was welded to the I-beams and the other end was welded to the floor. The forward posts (item "A") were tested in a mock-up configuration to meet the AAR specifications Nos. C-75 through -84, revised 1967. (See appendix H.) The height of the sill and floor plate on the power club car was 45.67 inches above the top of the rail.

Each passenger car was equipped with electric-pneumatically operated sliding type-doors on each end and on each side of the car. The doors could be automatically opened by inserting a key in the control panel. In an emergency, the doors could be opened manually by first breaking the glass in the control panel, located adjacent to the door, pushing in a valve, and manually operating a door handle which allowed the door to slide open. Operational instructions were indicated on a tag attached to the control panel.





"A" = Collision Posts (Center)

"B" = Collision Posts (Side)

Figure 4. -- Structural design of the engineman's cab front (turbotrain).

Steps at each door were covered by a trapdoor which, when opened, would extend the steps. The car was also equipped with a pair of retractable sliding/folding steps. These retractable steps were operated by insertion of a key in the control panel. No instructions were provided on the car for the operation of the trapdoor or folding steps.

Two emergency-escape windows were located in the center on each side of the cars. Emergency exit through these windows could be initiated after the window stripping was peeled away and the pane of glass pulled inward. However, several of the emergency windows were not properly identified. At one emergency window, the pull handle for the window stripping had been detached from the window stripping, but the stripping was still in place.

Passenger seating capacity for each car was as follows:

Type of Car	Seating Capacity
Power Club Car	27
Food Service Car	52
Coach Car	72
Coach Car	72
Coach Car	72
Power Car	40
Total	335

The seats in the coach cars were two-abreast units, supported by a single base frame. These two-seat units were designed to rotate 180° on their bases. Amtrak had arranged the seats in the coaches so that half the seats in the car faced forward and the other half faced rearward with both halves facing toward the center of the car.

The operating stations of the power cars were equipped with radios which the engineer could use to communicate with other trains and with operators along the route. These radios had three channels designated as Conrail road channels 1, 2, and Metro Region Commuter radio channel 3. The train was also equipped with a public address system that permitted announcements throughout the train.

OPSE-7.--OPSE-7 consisted of three U-28B General Electric Diesel locomotive units, 120 freight cars, and a caboose. Total gross tonnage of the train was 4,774 tons.

The height from the sill and floor plate of the diesel locomotive units to the top of the rail was 67.625 inches. Each locomotive unit weighed about 252,000 pounds and was equipped with a speedometer, a speed recorder device, and a 26-L type air brake system. Each unit was also equipped with radios with Conrail road radio channels 1 and 2. The radios were not equipped with the Metro Region Commuter radio channel 3.

Postaccident Inspection of Train Equipment

A speed tape was removed from the first and second locomotive units of OPSE-7. The tapes indicated that OPSE-7 had traveled approximately 4 miles after departing Glenwood on track No. 2, and the train had accelerated to about 37 mph before the train brakes were applied in emergency. The tapes showed a continuing decrease in speed until the trains collided between 8 and 10 mph.

Train No. 74 had traveled approximately 4 miles east of OW when it stopped. Two vertical I-beams were located at the forward end of the power car at Body STA. 0:00. (See figure 4.) These I-beams, identified as collision posts, had failed at the base welds and were pushed rearward about 7 feet. Outboard angled supports which were tied laterally to the vertical I-beams by welded steel structural members had failed at the floor attachment and had torn the floor material. The attaching welds had not failed. These posts were also pushed rearward about 75 inches. The car frame was bent downward until the forward section of the frame contacted the rail. The front AAR type E-coupler, mounted in a retractable coupler box, was found in the retracted position. The two pin-type locks which secured the coupler carrier in the extended position were found undamaged but pushed rearward to an angle of about 60° on both sides. The structural metal of the coupler carrier and the lock pin guides were bent and deformed. The lock pin retracting mechanism was severely bent and damaged. All exterior metal and fiberglass skin panels were destroyed to about 112 inches from the front. All four of the third-rail contact shoes were severely damaged.

In addition to being derailed, the food service coach of train No. 74 had contacted the third rail. Fire damage, confined to the exterior of the coach, existed in the area of the forward truck.

Track and Signal Information

At Dobbs Ferry, the railroad follows the shore of the Hudson River. There are four main tracks numbered from north to south as Nos. 3, 1, 2 and 4. Approaching Dobbs Ferry from the west, there is a 0°46' right-hand curve in the track about 1,980 feet long, then 895 feet of tangent track, followed by a 0°54' left-hand curve 2,310 feet long. The Conrail timetable designates the direction of the tracks as east and west.

The OW interlocking machine is electric, and the switches and signals are electrically activated. There are six tracks at the interlocking numbered from north to south as Nos. 5, 3, 1, 2, 6, and 4. Crossovers and switches are so arranged that eastward movements can be made from each of the six tracks to track No. 2. Three searchlight-type signals are mounted above and to the right of each track on a signal bridge for tracks Nos. 2 and 4. (See figure 5.) The numbers for the signals and switches correspond to the lever numbers on the lever frame in the tower.

The OW interlocking tower has a unit lever-type machine. (See figure 6.) The machine is equipped with 56 hand-operated levers: 33 levers control 34 signals; 19 levers control 20 switches, 3 levers control 4 electric locks, and there is 1 spare lever. The levers are a pistol grip-type which can only be moved by depressing the trigger in the handle. (See figure 6.) The blocking devices are metal boxes with opened ends.

Four automatic signals are located eastbound on track No. 2 between OW interlocking and the point of collision at Dobbs Ferry.

Postaccident Inspection of Signal Equipment

On the eastward signal mast for track No. 2 at OW interlocking, there was a fixture for a flashing letter "O", a train order signal; however, the signal had been electrically disconnected. A bracket for attaching a yellow flag or light, also a train order signal, to the tower building at OW was not accessible to the operator because the storm windows were nailed shut.

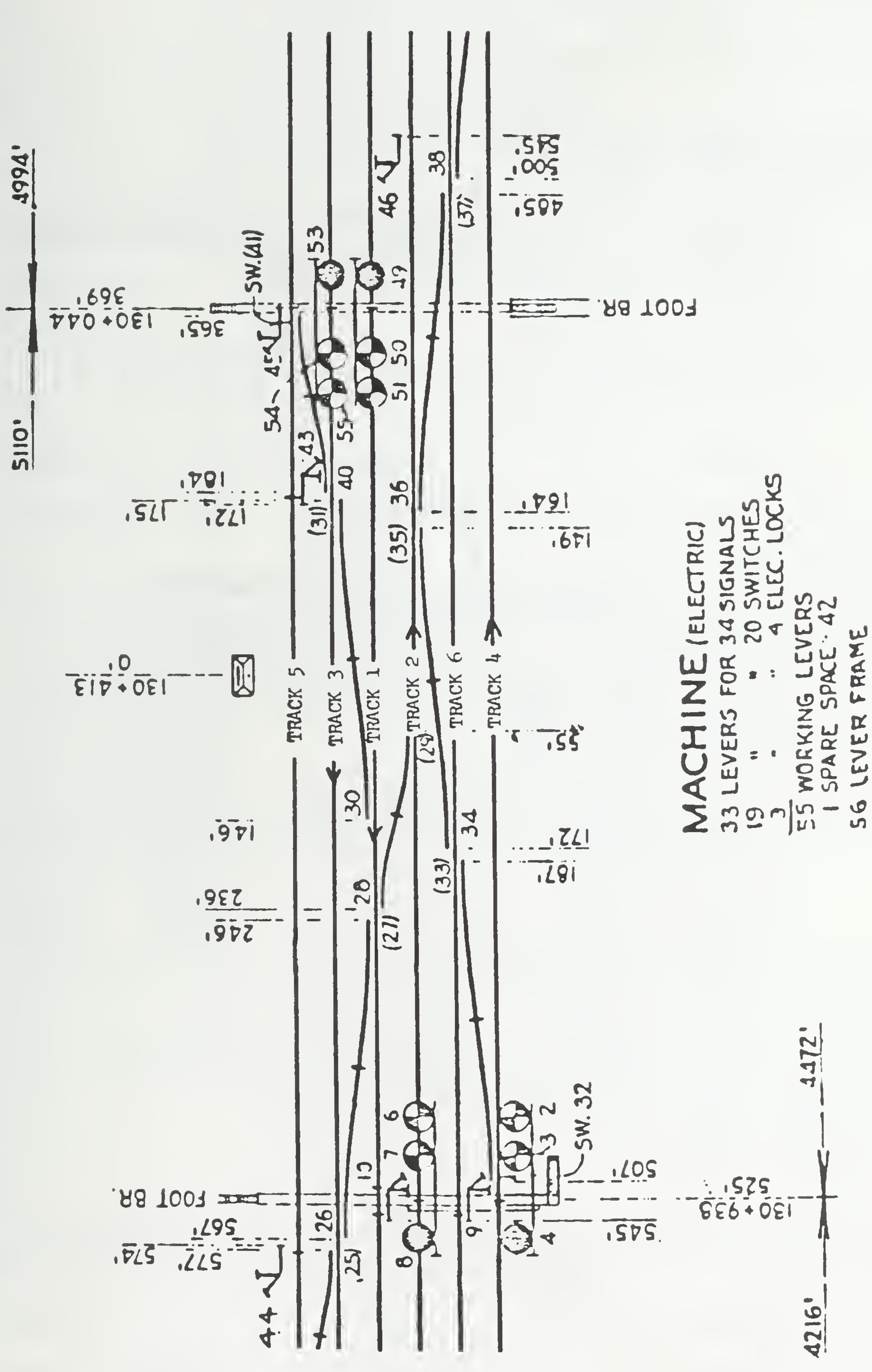


Figure 5.-- OW interlocking.

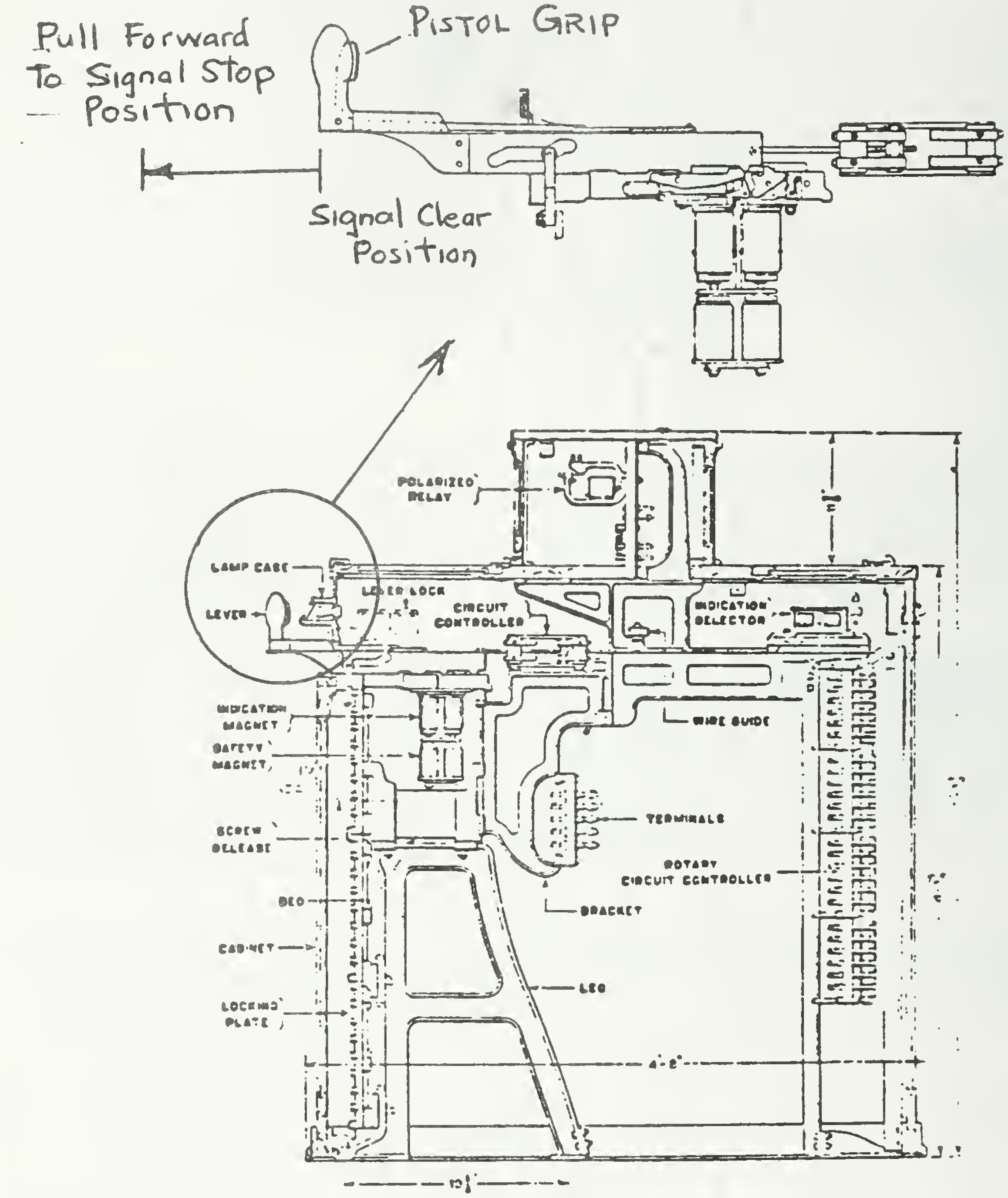


Figure 6.-- Unit lever-type machine.

Method of Operation

Trains are operated through Dobbs Ferry by signal indications of an approach color lighted automatic block signal system. Each track is signaled for the current of traffic, westward on track Nos. 1 and 3 and eastward on track Nos. 2 and 4.

Signal 21.12 controls the eastward movement into the block where the accident occurred and is 3,523 feet east of the collision point.

If the block beyond an intermediate signal is occupied by a train, the signal will display the following aspect:

Aspect	Name	Indication
Red over red	Stop and Proceed	Stop; then proceed at restricted speed.

If the block governed by the signal is clear and the block in advance of that block is occupied, the signal will display the following aspect:

Aspect	Name	Indication
Yellow over Red	Approach	Proceed not exceeding medium speed prepared to stop at next signal. Reduction to medium speed must commence before engine passes approach signal. Medium speed-not exceeding 30 miles per hour.

If the block beyond an intermediate signal is not occupied, but the third block ahead of the signal is occupied, the signal will display the following aspect:

Aspect	Name	Indication
Yellow over Yellow	Advance Approach	Proceed at limited speed prepared to stop at second signal. Reduction to limited speed must commence before engine passes signal. Limited speed not exceeding 45 miles per hour.

If three blocks in advance of the signal are unoccupied, the signal will display the following aspect:

Aspect	Name	Indication
Green over Green	Clear	Proceed

(See appendix D.)

When it is necessary to operate a train against the current of traffic in an automatic block signal system, Conrail Rule D-508 states:

> When a train is operated against the current of traffic, manual block signal system rules must apply.
>
> Operator may permit switching or similar movements against the current of traffic limited to a sufficient distance to clear the interlocking for a subsequent movement in the opposite direction.
>
> Operators must be granted permission for such movement when a train has been authorized to move in the direction of the point where the movement is to be made.
>
> When permission has been granted for a movement beyond the interlocking limits, the operator at that point and the operator in charge of the next block station or interlocking must know that the movement against the current of traffic has been completed before allowing a train to move in the direction of the point where such movement is being made.
>
> Block stations designated in the timetable indicate the limits of the manual blocks except as otherwise provided in Rule D-308."
>
> Block stations designated by timetable, bulletin order or train order indicate the limits of the manual block. When a train is directed by train order to run against the current of traffic to an interlocking remotely controlled, that portion of the main track between that interlocking and the first block station or interlocking in the rear will constitute a block for that train."

Train order No. 305, as issued by the train dispatcher, established the limits of the manual block as the remote interlocking at DV and the interlocking at OW.

Conrail Timetable Special Instruction 1157-C2 indicates that the maximum authorized speed of a freight train operating against the current of traffic between "MO" and "CD," which includes the accident site, is 40 mph. Conrail timetable special instruction 1157-C1 indicates that the speed of a passenger train in the area of the accident is 60 mph. (See appendix E.)

Conrail rules require that a form "J" holding order must be addressed to the operator at the point to be restricted before a train order is issued to a train to be operated against the current of traffic. The instructions state:

> These orders will be addressed to the operator and must not be transmitted by the train dispatcher until the operator has placed the fixed signal at "stop" for the track and in the direction of the approaching train to be held, displayed train order signal, applied blocking devices to switch or signal controls governing all routes to the track affected, and stated to the train dispatcher "stop signal and train order signal displayed."
>
> When a train has been so held, it must not proceed until the order to hold is annulled or an order given to the operator in the form:
>
> No.______________ ENG.______________ MAY GO.

Conrail Rules 201 states "Train order signal is indicated by a yellow flag by day or a yellow light by night attached to the building where train orders are delivered, or a flashing letter "O" attached to the mast of the fixed signal governing movement."

Conrail interlocking Rule 611 states "Signals must display their most restrictive aspects, except when cleared for an immediate movement, unless otherwise specified in timetable special instructions. Signals must be cleared sufficiently in advance of approach trains to avoid delay."

Conrail Rule 219 regarding train orders states "When the train order signal is displayed, unless otherwise restricted, the speed of a train receiving orders must not exceed 25 miles per hour to enable the operator to deliver the orders. If delivery is not effected to crew on the engine, the train must be stopped."

The Conrail Special Rules for train dispatchers are as follows:

901. Train dispatchers report to the Chief Train Dispatcher.
902. Train dispatchers are in charge of the movement of trains and have supervision over employees connected with those trains.
903. They will issue and record train orders, over the signature of the Superintendent and in accordance with the rules, and must issue such other instructions as may be required for the safe and efficient movement of trains.
904. They must be familiar with the physical characteristics of the territory in their charge, and with all General Orders, Bulletin Orders, Division Notices, and other instructions relating to the movement of trains which are in effect on their territory.
906. They must report immediately to the Chief Train Dispatcher any violation of the rules and any irregularities relating to the movement of trains.
908. They must be conversant with the requirements of the Special Instructions Governing Operations of Signals and Interlockings that relate to their duties.
909. They must require those responsible to report promptly the departure, passing and arrival of trains. In the event of accidents or the existence of hazardous conditions, immediate action must be taken for the protection of trains.

For operators, the rules are as follows:

911. Operators, train directors, their assistants and levermen report to the Chief Train Dispatcher or Supervisor of Operating Rules.
912. They must be qualified at that particular block or interlocking station before accepting an assignment for duty.
913. They are responsible for delivery of train orders and messages, the use of blocks, tracks, interlocking switches and signal, and for prompt movement of trains in accordance with the rules. They must see that General Orders, Bulletin Orders and Division Notices are posted promptly in the proper location.
914. They must obey the instructions of the train dispatcher and advise him immediately of any condition which may affect normal operation or safety of train movements. They must report the weather as required; and in case of sudden change, high water, storm or fog, promptly advise the train dispatcher.
915. Operators must promptly record and report to the train dispatcher the direction, time of arrival, time of departure, and when directed, the engine number of all trains.

They must maintain an accurate and legible station record of train and track car movements, and record any pertinent information affecting the movement of trains.

916. . . They must repond promptly when called by radio or telephone, and communicate clearly and properly in compliance with the rules.

* * * * *

Conrail operational procedures 5/ require supervisors to observe the performance of employees and to take corrective action upon noting noncompliance with the rules. Supervisors are required to record the observations showing compliance or noncompliance with the rules during the observation. (See appendix F.) In an August 17, 1978, letter to the Safety Board, Conrail states that, "The value of trained employees is unquestionable. To evaluate the effectiveness of the present training program is to observe the performance of the individual trained. Observance of employee's performance by supervisory personnel using 1872 efficiency forms (POSTS Program) give management a periodic check as to rules compliance or violation. These checks are recorded." However, Conrail does not specify how often these checks are to be conducted on operators.

Conrail further stated in its letter that an operator is qualified and his proficiency is checked "By successfully completing his on-the-job training, and by being examined on his knowledge of operating and safety rules before performing service. Mandatory re-examinations yearly or bi-yearly revalidates his proficiency, as well as periodic rules compliance checks (POSTS Program)."

According to Conrail timetable special instruction 1702-A2, Metro Region Commuter Radio Channel 3 is in operation between GCT (Grand Central Terminal) and CD (Harmon). (See appendix E.) Conrail freight locomotive units are equipped with radios that have the capability to receive or transmit on channels 1 and 2 but not on channel 3. Amtrak locomotives are equipped to operate on all three radio channels. Both the OW and DV towers have radios that receive and transmit on channel 3 and on Conrail road channel 2, and which are monitored simultaneously in addition to the open telephone line with the dispatcher.

Title 49 CFR Part 220.23 requires that railroads "designate appropriate radio channels by publishing them in a timetable or special instruction." Part 220.39 further requires "Engine and caboose radios must be turned on to the appropriate channel as designated in ¶ 220.23 with the volume adjusted to receive communications while the engine or caboose is manned." (See appendix F.)

In the accident area, there are 103 scheduled passenger trains operating each day, including Conrail Commuter Trains and Amtrak through passenger trains.

Meteorological Information

The Westchester County Airport, located 4 miles north of the accident site reported the weather at 3:45 p.m., as temperature 62°, mostly cloudy, daylight with a 9 mph wind blowing from the west. Visibility was 7 miles.

Survival Aspects

When the trains collided, passenger train No. 74 was stopped and freight train No. OPSE-7 had slowed between 8 and 10 mph. The lead freight locomotive unit overrode the passenger train power car. The operating cab was crushed; the engineer's console, the fireman's seat, and all intervening structure were pushed about 112 inches from the front

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5/ Required by 49 CFR Part 217.9.

end of the unit rearward into the electrical locker. In addition to crushing the operating cab, train No. 74 was pushed rearward 112 feet. The engineer and fireman were injured when they jumped from the operating cab to the ground before the collision.

Many of the passengers, who had no warning before the collision and were not aware of the impending collision, were thrown forward into seatbacks at impact. Many seats rotated when struck from behind when passengers were thrown against them. The largest number of injuries to passengers were to the legs when they became caught under the seats ahead. The next largest number was facial lacerations, bruises, and teeth broken and knocked out. One female passenger was seriously injured and required emergency surgery.

When a fire started outside of the second car, the conductor and a trainman removed a fire extinguisher from the power car to extinguish the fire. There was some panic when word of the fire spread through the cars and passengers began to smell the smoke. However, this was of a short duration and when the passengers realized the fire was not spreading, they calmed down.

Passengers experienced extreme difficulty when they attempted to evacuate the cars. Many passengers tried to push the emergency windows outward; however, because the windows were designed to be taken out by pulling inward, they would not open. Other passengers could not determine how to open the trapdoor over the steps, so many passengers jumped from the car to the ground.

The Westchester County disaster plan resulted in speedy response by police, fire, and rescue personnel, and in the swift evacuation of the passengers. The Dobbs Ferry Police Department was notified of the accident at 4:13 p.m. They immediately dispatched personnel to the accident site, requested ambulances, and notified local hospitals. The Fire Department and the Dobbs Ferry ambulance arrived simultaneously within 12 minutes after being notified. The Dobbs Ferry Hospital had its disaster plan in effect within 5 minutes after notification. Previous drills conducted by the hospital and ambulance corps were of substantial benefit in the prehospital response. The hospital's disaster plan was so detailed that doctors and nurses knew which streets to take to avoid blocked traffic.

ANALYSIS

Protection For Trains

When the dispatcher decided to run train OPSE-7 against the current of traffic, the primary safeguard-placing a blocking device on the signal lever and the primary redundant feature - displaying the train order signal - were ignored by the OW operator. Additionally, the dispatcher failed to comply with the instruction governing the "J" holding orders which required him to assure that the train order signal was displayed.

The action of the OW operator in displaying a clear signal for train No. 74 to proceed onto a segment of track in conflict with an opposing train which had been given absolute rights by a train order is a perfect example of why its necessary to block signal levers in such operations. Throughout the years, investigation of accidents and incidents have shown that human failure cannot be eliminated completely; therefore, the needed redundant requirement to display the train order signal which made the engineer of a restricted train also responsible for not passing the point where the train order was in effect was lacking. The dispatcher violated a Conrail rule by transmitting a holding order to the OW operator without requiring the operator to state that "stop signal and train order signal displayed". A further safeguard would have been to address the order to the engineer of train No. 74; however, this is not required by Conrail operating rules.

The dispatcher had been working regularly on his assignment for about 1 year 6 months and had been regularly issuing train orders to operators without requiring them to display the train order signal and confirm it with the statement required by the rules. This practice was also being followed by the dispatcher when he was an operator and he could not display a train order signal. The OW operator stated that in his year's experience, he had been led to believe through on-the-job training that it was acceptable to state to the dispatcher, "BDA," and then copy the train order before applying the blocking device. That is contrary to the intent of the required exchange between an operator and a dispatcher which is to insure that a blocking device is applied and confirmed before the order is transmitted.

The Conrail management had to have known if they have been performing periodic inspections, that improper procedures were being used, such as no train order signals being displayed at towers because the operators did not have the ability to do so. Thus, it seemed a fair inference that Conrail management had been condoning the procedures through acquiescence. Further, the disconnecting of the flashing "O" train order signal, the nailing shut of the window which prevented the display of the train order signal at the OW tower, and the existence of this situation for at least 4 years seems to confirm that Conrail management had been condoning improper train order procedures. The situation was worsened by the fact that an improperly trained operator, who had acquired the bad habit of replying BDA (blocking device applied) before actually doing so, had been working for more than a year without being checked in the performance of his duties by a supervisor.

Radio Communications

Since the engineer of OPSE-7 received his train order on channel 2 and train No. 74 was on channel 3, the engineer of train No. 74 was not alerted by radio traffic on channel 2 that OPSE-7 was operating on track No. 2 from the opposite direction. No. 74 was monitoring channel 3 in compliance with the timetable special instructions and OPSE-7 was not monitoring channel 3 because the Conrail freight locomotive units are not equipped with a radio with channel 3. However, the Conrail timetable had established limits of operation that required the use of channel 3 in the area of the accident. If both trains had been operating on the same radio channel, the engineer of train No. 74 may have heard the train order given to the engineer of OPSE-7 to use track No. 2 and thus have been alerted that an opposing move was being made, and have stopped his train on track No. 2 at OW. If train No. 74 had stopped at OW, this accident would have been prevented. However, Conrail management instead of having their freight train locomotives equipped with radios to receive and transmit on channel 3 so that the engineers could comply with the timetable instructions, equipped the towers with a radio with channel 2. The operators then monitored channel 2 and 3 simultaneously and when necessary could transmit train orders to freight trains on channel 2.

The conflict between the Conrail timetable instructions and the Conrail procedures for operation of train radio on different channels between MO Tower, Bronx, New York, and CD Tower, Harmon, New York, which includes the area of the accident, is a failure to comply with 49 CFR Part 220.39 requiring radios to operate on the designated channel. The engineer of OPSE-7 could not turn to channel No. 3, as specified by the timetable and required by 49 CFR Part 220.23, because his locomotive was not equipped with a radio to operate on channel 3. This is another example of the failure of management and supervision to ensure that operations were conducted in accordance with Conrail rules and Federal requirements for safe train operations.

Crashworthiness

Since the sill section and floor plate of train No. 74 were 21.9 inches lower than the sill and floor of the freight locomotive unit of OPSE-7, the operating cab of the power car was not survivable in this accident. Penetration of the power car at this height above the floor plate insured failure of the cab's forward structure.

Although the I-beam forward posts of the power car were intended to be collision posts, they failed to provide any protection since they were torn loose and pushed rearward even in a relatively low speed collision. In the test mockup that was performed on the collision posts before they were installed in the power car, the collision posts were welded to an I-beam before the test loading was applied. (See appendix H.) The actual installation of these collision posts differed from the testing because they were welded only to the much thinner floor plate. In this accident, the collision posts tore loose from the floor plate, or tore the floor plate metal. It is evident that modern passenger equipment, such as that used on train No. 74, will always sustain extensive damage in a collision with conventional locomotives because of the incompatibility of the rigid frames; its frame being approximately 21 inches lower than standard railroad equipment. Apparently, this matchup was not considered when the turboliner equipment was adopted for use on American railroads.

The Safety Board identified the lack of crash protection provided the occupants of locomotives in an accident at Riverdale, Illinois, on September 8, 1970, 6/ and made a recommendation to the FRA for timely improvement of the crashworthiness of railroad equipment particularly as it is related to the protection of the occupants of locomotive control compartments. In a letter to the Safety Board dated May 3, 1971, the FRA outlined its concern for this problem and set up a meeting with the locomotive and car builders, labor organizations, carriers, and the AAR. (See appendix I.) On January 16, 1973, the FRA advised the Safety Board that a locomotive control compartment committee had been organized, that the AAR had requested a contractor to design a program of testing to determine locomotive cab crashworthiness, and that the test program would set requirements for anticlimbing devices and design requirements for locomotive crash posts and pilots. However, this committee, still in existence, has not published any minimal criteria for the structural design of locomotives. Since the original meeting in 1971 with the FRA, numerous accidents 7/ have been investigated by the Safety Board in which crashworthiness and collision posts have been identified as inadequate to provide protection to the occupants of locomotive control compartments. Amtrak apparently gave little consideration to crashworthiness in the design and adaptation of the turboliner power cars as demonstrated by the extensive damage done to the locomotive cab in this relatively low speed collision. The damage to the cab would have made it unsurvivable for the occupants if they had remained in the cab. The acquisition of this lighter and lower turboliner equipment was possible because of the lack of design requirements estabished by the FRA for locomotive construction.

6/ Railroad Accident Report—"Illinois Central Railroad Company and Indiana Harbor Belt Railroad Company Collision Between Yard Trains at Riverdale, Illinois, on September 8, 1970" (NTSB-RAR-71-3).

7/ Railroad Accident Report—"Freight Train Derailment Passenger Train Collision with Hazardous Material Car, Sound view, Connecticut, October 8, 1970" (NTSB-RAR-72-1); Railroad Accident Report—"Derailment of Extra 5701 East at Sherman, Wyoming, March 28, 1971" (NTSB-RAR-72-4); Railroad Accident Report—"Collision of the State-of-the-Art Transit Cars with a Standing Car, High Speed Ground Test Center, Pueblo, Colorado, August 11, 1973" (NTSB-RAR-74-2); and Railroad Accident Report--"Head-End Collision of Louisville and Nashville Railroad Local Freight and Yard Train at Florence, Alabama, September 18, 1978" (NTSB-RAR-72-2).

In its investigation of an accident at Goldonna, Louisiana, on December 28, 1977, 8/ it was determined that the lack of crashworthiness features on the locomotive caused the death of two crewmembers. Because of this investigation, the Safety Board issued to the FRA recommendation R-78-27 which requested that it expedite its study of improvements to the design of locomotive operator compartments to minimize crash damage. The Safety Board reiterates this recommendation to the FRA and strongly urges that the crashworthiness study be accelerated so that the problem of inadequate crash protection for the occupants of locomotive cabs can be swiftly resolved.

Many passenger injuries were sustained when passengers were thrown forward into seatbacks and the seats rotated because of inadequate locking devices. Other passengers sustained injuries when they were thrown forward and their legs became trapped under seats. The Safety Board has investigated other accidents 9/ involving passenger injuries caused by inadequately locked seats.

The Safety Board identified fixtures within passenger cars as injury-producing in its investigation of an accident at Glendale, Maryland, on June 28, 1969, 10/ and recommended to the FRA that it initiate studies to determine the relationship between rail passenger car design and passenger injury and, where practical, take action to improve in the design of future high-speed and rapid transit passenger cars. Amtrak has placed many cars in service since that report was issued. The Safety Board has investigated other accidents 11/ in which passenger injuries have been caused by the fixtures within the car. No Federal regulations exist for even minimum standards for interior design of passenger cars. Amtrak's newest cars still have some of the same injury-producing equipment that was cited in past Safety Board investigations.

A 1978 crashworthiness study 12/ conducted by the FRA identified seat rotation as being a cause of passenger injuries and concluded that it is necessary to "prevent double seats from swiveling by providing a positive lock to improve occupant containment." (See appendix G.) The problem of leg entrapment was also identified as a significant cause of

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8/ Railroad Accident Report—Collision of a Louisiana and Arkansas Railway Freight Train and a L. V. Rhymes tractor-semitrailer at Goldonna, Louisiana, December 28, 1977 (NTSB-RHR-78-1).

9/ Railroad Accident Report-"Rear End Collision of Conrail Commuter Train No. 400 and Amtrak Passenger Train No. 60, Sea Brook, Maryland, June 9, 1978" (NTSB-RAR-79-3), and Railroad Accident Report "National Railroad Passenger Corporation (Amtrak) Head-End Collision of Train No. 111 and Passenger Track Machine Equipment, Edison, New Jersey, April 20, 1979" (NTSB-RAR-79-10).

10/ Railroad Accident Report—"Penn Central Company Train Second 115 (Silver Star) Derailment at Glendale, Maryland, June 28, 1969" (RAR-70-1).

11/ Railroad Accident Report—"Richmond, Fredericksburg and Potomac Railroad Company Train No. 10/76 Derailment with Three Fatalities and Numerous Personal Injuries, Franconia, Virginia, January 27, 1970" (NTSB-RAR-71-1); Railroad Accident Report—"Derailment of Amtrak Train No. 1 while operating on the Illinois Central Railroad near Salem, Illinois, June 10, 1971" (NTSB RAR-72-5); Railroad Accident Report--"Collision of Illinois Central Gulf Railroad Commuter Trains, Chicago, Illinois, October 30, 1972" (NTSB RAR -73-5); Railroad Accident Report—"Derailment of an Amtrak train on the tracks of the Atchison, Topeka and Santa Fe Railroad Company, at Melvern, Kansas, July 5, 1974" (NTSB-RAR-75-1); and Railroad Accident Report—"Collision of two Penn Central commuter trains at Botanical Garden Station, New York City, January 2, 1975" (NTSB RAR-74-8).

12/ "Rail Safety/Equipment Crashworthiness." FRA/ORD 77/73.

passenger injuries in the FRA study. The report concluded that there was a need to "prevent leg entrapment under seats by adding a back skirt to reduce high frequency of leg injury in collisions."

Since the findings of the FRA study identified the injury-producing fixtures that are present in passenger train accidents, the Safety Board finds it difficult to understand why the FRA has not yet taken steps to require correction of these unsafe and obvious injury-producing conditions. The Safety Board reiterates to the FRA the urgent need for establishing passenger car safety standards.

Emergency Evacuation

Instructions for opening the trapdoors, which covered the steps at the side door locations, were not posted and the passengers were required to jump from the floor level of the car to the ground. The failure of Amtrak to provide adequate instructions for emergency evacuation resulted in additional passenger injuries.

Some emergency escape windows were not identified. One handle needed for removing the window stripping to effect an emergency escape was separated from the window stripping. Instructions were not posted to advise passengers that the window glass must be pulled inward to remove it. These conditions prevented the passengers from removing some of the windows and resulted in panic when the passengers smelled smoke and thought they were trapped. If adequate instructions had been displayed in the cars outlining the operation of trapdoors and emergency escape windows, the panic and the injuries sustained as a result of jumping to the ground may have been avoided.

The flagman and engineer jumped from the power car of train No. 74 when they realized that collision was imminent. This action saved their lives. However, they did not have sufficient time to warn the passengers of the impending collision. Because the conductor and a trainman were occupied in extinguishing the fire outside the second car, only one trainman was available to assist passengers in the rear of the train. No crewmen assisted the passengers in the second, third, and fourth cars.

Training and Supervision of Operator

The OW operator stated that he had been trained to apply the blocking device after copying a train order. Additionally, the operator said that he learned the improper procedure from other operators during his on-the-job training. The operator's statement indicates that other operators were following this unsafe practice, even though it was a violation of Conrail Rules for a "J" holding order. This situation at the OW tower highlights a problem with on-the-job training - if the employees used to train new employees are using improper and unsafe procedures, these methods are being taught to the new employees. Therefore, it is evident that Conrail needs to improve its overview and direct supervision of on-the-job training for operators.

Federal regulations require that Conrail make periodic tests and inspections to determine the extent of compliance with its operating rules, timetables and special instructions by its operating employees. Records must be retained and made available to the FRA so that performance can be checked by FRA.

Conrail's training of the OW operator was inadequate because it did not assure that he was copying and delivering train orders according to the rules. The absence of supervisory monitoring during his first year of work as an operator resulted in the

operator's failure to comply with that train order practice which requires the application of a blocking device to the pertinent signal lever and the display of the train order signal before copying a train order. Since the dispatcher also failed to require the display of the train order signal before transmitting the train order, it suggests that the questionable practices may be widespread on this division.

Conrail's program which was submitted to FRA failed to accomplish its intent - to assure the understanding of the rules and compliance with them. FRA's monitoring of Conrail to determine if it were following its program was also ineffective. The Safety Board questions the adequacy of Federal oversight in this case to insure the Conrail program of operating tests and inspections that allows an employee, such as the OW operator, to be hired, trained on the job, and work for over a year without any supervisory review of his performance.

The Safety Board is concerned for the safety of train operations on the Metropolitan Region of Conrail because of the large volume of passenger traffic. The apparent failure of Conrail management to recognize the danger of failing to take corrective action to bring train operations in compliance with their operating rules and timetable special instructions must be corrected. Therefore, the Safety Board urges the FRA to immediately launch a safety review of the operation of trains on the Metropolitan Region of Conrail to bring those operations in compliance with the operating rules and timetable instructions as issued by Conrail.

CONCLUSIONS

Findings

1. The operator at OW interlocking operated the signal lever which permitted train No. 74 to obtain a clear signal because he failed to remember that an opposing train order was issued to OPSE-7 and that he had not applied a blocking device to the signal lever.

2. The operator at OW interlocking did not display a train order signal. Therefore, train No. 74 proceeded on a clear signal. The operator could not display a train order signal because the wiring to the signal had been disconnected, and because the windows were nailed shut, the alternate method of hanging a yellow light or flag on the tower could not be used.

3. Conrail condoned the unauthorized train order practice of not displaying a train order signal which violated their own operating rules.

4. The engineer of train No. 74 was not aware that OPSE-7 was westbound on track No. 2 because he was monitoring radio channel 3, as directed, while OPSE-7 was receiving train orders on channel 2, as directed.

5. Conrail freight trains cannot monitor radio communications to passenger trains from Grand Central Terminal to Harmon because Conrail freight locomotive units are not equipped with radios that have Metro Region Commuter radio channel 3, the established channel for operations in the area of the accident. Failing to provide freight locomotives with a radio for channel 3 is a poor operating practice and a violation of Conrail rules and Federal regulations.

6. Because no supervisor had conducted a check of his job performance in the year and 22 days of his employment, the operator continued to use the improper practice of not applying the blocking device to the signal lever which he had learned due to improper instruction during his on-the-job training.

7. The Federal Railroad Administration Regulation 49 CFR 217.9 does not require Conrail or any other railroad to have a plan to regularly check specific employees, such as operators, in the proficiency of their job performance.

8. The operating cab of the power car of train No. 74 was destroyed in the low-speed collision because of the lack of adequate crashworthiness features.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the failure of the OW operator to apply a blocking device to the signal lever which permitted him to clear the signal and allowed train No. 74 to proceed on an occupied track, and Conrail's condoning the transmission of train orders without requiring the operator to display the train order signal. Contributing to the accident were the improper training and inadequate supervision of the tower operator, and the failure of Conrail to provide a reasonable means of displaying train order signals at OW. Contributing to the injuries were the design of the seats and lack of emergency evacuation instructions.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the Federal Railroad Administration:

Conduct a safety review of the Metropolitan Region to determine why the actual operation of trains was not in compliance with Conrail rules, and provide the Safety Board a report of the findings. (Class II, Priority Action) (R-81-52)

Amend 49 CFR 217.9 to require sufficient monitoring to insure that each operating employee is evaluated for compliance with operating rules on a regular basis. (Class II, Priority Action) (R-81-53)

--to the Consolidated Rail Corporation (Conrail):

Establish better procedures for the training and followup by supervisors of operators and dispatchers to insure compliance with the rules. Provide formal training. (Class II, Priority Action) (R-81-54)"

Require that all trains operating on the main line monitor the same channel as designated in the timetable. (Class II, Priority Action) (R-81-55)

Provide the operators on the Metropolitan Region with the ability to display a train order signal at train order stations as required by the operating rules. (Class II, Priority Action) (R-81-56)

--to the National Railroad Passenger Corporation (Amtrak):

Establish a retrofit schedule to provide skirts at the bottom of seats to prevent leg injuries because of leg entrapment. (Class II, Priority Action) (R-81-57)

Install an adequate locking device on rotating seats which will prevent undesired rotation in accidents. (Class II, Priority Action) (R-81-58)

Revise turbotrains to improve cab crashworthiness in a collision. (Class II, Priority Action) (R-81-59)

Promptly provide for passengers identification of emergency exits which includes instructions for proper use. (Class II, Priority Action) (R-81-60)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ G. H. PATRICK BURSLEY
Member

PATRICIA A. GOLDMAN, Member, did not participate.

April 28, 1981

APPENDIXES

APPENDIX A

INVESTIGATION

The National Transportation Safety Board was notified of the accident about 4:50 p.m., on November 7, 1980. The Safety Board immeditely dispatched two investigators from its New York Field office and two investigators from its Washington, D. C., Headquarters office to the scene. Investigation of operations, vehicle factors, and human factors were conducted.

APPENDIX B

CREWMEMBER INFORMATION

OW Interlocking Station

Operator J. G. Quirk, 32, entered service on October 16, 1979, passed a company physical on October 26, 1979, and was last examined on the company operating rules on February 8, 1980. The operator's first assignment was at OW interlocking where he posted (worked with the regular operator) on all three shifts, for 57 days. At the beginning of the posting period, he attended a 4-day class of instruction on the Rules of the Transportation Department. Before finishing the posting period, the operator passed an 85-question examination on the Rules of the Transportation Department with an 89-percent score.

The operator was first assigned to the second shift on February 25, 1980, without a qualified operator's supervisor. He had worked 34 days on second shift and a total of 40 days on first and third shifts at OW interlocking up to the date of the accident.

Dispatcher R. F. Thompson, 27, entered service in 1976 and was promoted to dispatcher in 1979. He had been off duty for 16 hours before reporting for duty at the C-desk, 357 Madison Avenue, New York, N.Y. regional headquarters on November 7, 1980. He was last physically approved by a company doctor on October 16, 1979.

Train No. 74

Engineman W. K. Balluff, 63, entered service in 1942, was promoted in 1962, and was last examined and approved by a company physician in 1979. He last attended a class on the carrier's operating rules and air brakes in 1979.

Fireman W. R. Edell, 35, entered service in 1969 and was promoted to engineman in 1973. He was last examined and approved by a company doctor in 1980, attended a class on the carrier's operating rules in 1980, and attended air brake class in 1979.

Conductor J. C. Redgrave, 36, entered service in 1974, was promoted in 1977, and was last examined and approved by a company doctor in 1978. He attended a class on the carrier's operating rules in 1980 and attended an air brake class in 1979.

Trainman A. J. Petronis, 63, entered service in 1945, was promoted in 1951, and was last examined and approved for service by a company doctor in 1980. He attended classes on the carriers operating rules and air brake rules in 1980.

Trainman J. P. McMahon, 62, entered service in 1941 and was last examined and approved by a company doctor in 1978. He attended a class on the carrier's operating rules and airbrake rules in 1980.

Train OPSE-7 Extra 2806 West

Engineman A. J. O'Brien, 57, entered service in 1942, was promoted in 1964, and was last examined and approved by a company doctor in 1980. He attended a class on the carrier's operating rules in 1980 and the air brake rules in 1979.

Conductor J. Saleski, 40, entered service in 1974, was promoted in 1977, and was last examined and approved by a company doctor in 1978. He attended a class on the carrier's operating rules and air brake rules in 1980.

Head-end Brakeman R. Anselmo, 43, entered service in 1955 and was last examined and approved by a company doctor in 1979. He attended class on the carrier's operating rules and air brake rules in 1979.

Flagman T. Dougherty, 48, entered service in 1951 and was last examined and approved by a company doctor in 1979. He was examined on the carrier's operating rules and airbrake rules in 1979.

APPENDIX C

TRANSCRIPT OF THE DISPATCHER'S OPEN WIRE INCIDENT INVOLVING OPSE-7 AND NO. 74 ON NOVEMBER 7, 1980.

Beginning 15:45:45

15:45:49

DV:	Spike.
DISPATCHER:	Yeah Alex.
DV:	You said on figuring on holding the freight on 2 until after the rush hour right?
DISPATCHER:	Uh, we may be able to handle him as soon as I get the O.K. from the Upper Hudson, Alex.
DV:	O.K., then it would be shortly.
DISPATCHER:	Yeah, it should be shortly.
15:46:20 DISPATCHER:	Out a minute. Out a minute.
15:47:46 DISPATCHER:	Back. Back. Alex, what time the deadhead over to 4 at Glenwood?
DV:	3:44 and 739 on 3 at 3:46.
DISPATCHER:	OW (no answer)
15:48:55 DISPATCHER:	OW
OW:	OW
DISPATCHER:	What was your last on 2 eastbound, George?
OW:	Last 2 east was a deadhead, track 2 at 3:24.
DISPATCHER:	All right. B.D.A. 2 east.
OW:	B.D.A. signal 6 at 3:49.
DISPATCHER:	All right, let me know when you're ready for an order.

OW:	O.K. O.K. ready.
15:49:42 DISPATCHER:	 OW, this will be 304, todays date to the Operator at OW. Hold all eastward e-a-s-t-w-a-r-d trains. Clear of Number 2 t-w-o track between OW, capital O capital W, and Glenwood capital G-l-e-n-w-o-o-d. L.W.M.
OW:	OW Train Order 304, November 7, 1980 to Operator at OW. Hold all eastward trains clear of Number 2 t-w-o track between OW, capital O capital W and Glenwood, Capital G-l-e-n-w-o-o-d. L.W.M.
DISPATCHER:	All right 304 complete 3:50 P.M. L.W.M.
OW:	304 complete 3:50 P.M. L.W.M. G.Q.
15:50:49 DISPATCHER:	 Hello Spike.
DV:	Spike.
DISPATCHER:	Alex, ask OPSE if his head engine is 2806.
DV:	Right.
15:51:20 DV:	 2806.
DISPATCHER:	All right. Let me know when you're ready for an order Alex.
DV:	Go ahead Bob.
DISPATCHER:	OW, you're ready for another one George?
OW:	Ready.
DISPATCHER:	At OW 305 today's date Operator OW. Spike 305. Today's date C&E Extra 2806 at Glenwood. Care of Operator and Operator at DV Extra 2806, t-w-o e-i-g-h-t z-e-r-o s-i-x West w-e-s-t has right over opposing trains on Number 2 t-w-o track Glenwood, capital G-l-e-n-w-o-o-d to OW, capital O capital W. L.W.M.
OW:	OW. Train Order 305, November 7, 1980 to Operator at OW Extra 2806, t-w-o e-i-g-h-t z-e-r-o s-i-x west has right over opposing trains on Number 2 t-w-o track Glenwood, to OW, capital G-l-e-n-w-o-o-d, O capital O capital W.

DV: Spike 19 Order 305, November 7, 1980 to C&E Extra 2806 at Glenwood care of Operator and Operator at DV. Extra 2806 t-w-o e-i-g-h-t z-e-r-o s-i-x west w-e-s-t has right over opposing trains on Number 2 t-w-o track Glenwood, capital G-l-e-n-w-o-o-d to OW, capital O capital W. L.W.M.

DISPATCHER: All right 305 complete OW and Spike at 3:54 P.M. L.W.M.

OW: OW Train Order 305 made complete 3:54. L.W.M. G.Q.

DV: Spike 305 complete 3:54 P.M. L.W.M. F.D.E.
Want a repeat time on that OPSE and the name of the man who took it?

DISPATCHER: What's that Alex?
Oh yeah, repeat time.
An OW can we get the clear block for Extra 2806 West?

OW: O.K., you have the block at 3:54.

DISPATCHER: O.K. Alex. 3:54 P.M. clear block Glenwood to OW. He doesn't need an A card.

DV: Roger.

15:55:50
DISPATCHER: Alex, there's alot of static on the radio.
Make sure he gets it before you go any further.

DV: Right.

15:57:17
DISPATCHER: O.K. Hello, OW.
Hello OW.
OW - OW
74 Can you ask him if the bridge plates are being removed at Tarrytown when he shows?

OW: O.K.

15:57:37
DV: Spike.

DISPATCHER: Yeah Alex.

DV: West of Glenwood 739 on 3, 3:57 the deadhead eastbound on 4 at 3:52 and you can make the receiving time on that order 3:57 by A.J. O'Brien, engineer.

DISPATCHER: O.K. Alex. 770 is on 4. Behind him, 74.

DV: Roger and O.K. to let the freight west on 2.
DISPATCHER: Right.
(conversation with HM - Circuit trouble (east of CR)

16:00:27
DISPATCHER: OW.

OW: OW, what was that signal number?

HM: The approach at Harmon, Track 3.

OW: O.K. I'll tell them.

DISPATCHER: O.K., let me know when 739 shows and if 74 reports the bridge plates clear, George.

OW: O.K.

HM: Everything is going to keep coming 1 right?

DISPATCHER: Uh, No, 739 will be your first on 3.

HM: O.K., Roger.

16:02:57
OW: OW

DISPATCHER: Yeah George.

OW: I heard from Mule, he's at Tarrytown removed the bridge plate at Tarrytown Station. He would like an M Form to work on Track 1 OW to CR he wants to change some angle bars at the scene of that location.

DISPATCHER: Ask him if it is absolutely necessary, George. We have track 3 with a restriction and a red signal.

OW: All right.

DISPATCHER: And if it is, how long is it gonna take them?

OW: O.K.

16:04:19
OW: OW.

DISPATCHER: Yeah George.

OW: Yeah, Mule says he has orders from his office, Collins or somebody, that he has to, he just wants the track out on 1 and he wants to change the angle bars on 3.

DISPATCHER: Is that where that hole in the rail is? Will that, will that, take away the restriction when he's through? (pause)

OW: Yeah, he said once he is finished he will take the speed restriction off.

DISPATCHER: How long is he gonna need, George? (pause)

OW: He says 2 to 2 1/2 hours.

DISPATCHER: No way 2, 2 1/2 hours. After the rush, he's gonna have to wait, George.

OW: O.K. (16:05:37)

16:07:30
DISPATCHER: OW.

OW: OW.

DISPATCHER: You tell Mule after the rush?

OW: Yeah, I told him.

DISPATCHER: O.K., You're B.D.R. . . You didn't have a B.D.A. on 3, huh? We just had a verbal block, right?

OW: Yeah.

DISPATCHER: O.K., you could remove that verbal block and 739. Any train going 3 will have to get that restriction 29 point 1, 29 point 2, 15 miles an hour.

OW: O.K.

16:08:01
DISPATCHER: Hello Spike.

DV: Spike.

DISPATCHER: Alex, the freight go west at Glenwood?

DV: Make him 4:08 at Glenwood on 2.

DISPATCHER: Thank you.

16:14:01
DISPATCHER: OW.

OW: OW.

DISPATCHER: All right George, when this freight calls when this freight shows you can tell him the Upper Hudson has only one track till 5 o'clock. We are not gonna move until at least 5 o'clock.

OW: O.K., he's gonna stay here then.

DISPATCHER: Yeah, hold him east of you on 2.

OW: Right.

16:16:20
OW: OW west 739 track 3, 4:15. He had no radio. I had to stop him by the tower to give him the message.

DISPATCHER: O.K., thanks George.

16:18:59
OW: OW east 770 looped 3:45
74 track 2, 4:08
772 track 4, 4:18

DISPATCHER: 74 went 4, right? (pause)
George, 74 went 4. (pause)

OW: Uh Oh. I think on my sheet. I have two here written.

DISPATCHER: Well, you know we went 4 though, right? If he went 2 tell him to stop his train.

OW: Let me get a hold of him.

16:21:08
DV: Spike.

DISPATCHER: Yeah, Alex.

DV: 74 wants the rail dead on track 2. . on track 2 there -- OW --.

DISPATCHER: Yeah. We're killing it now. Where, where, can you, can you raise, can you raise either 74 or the SELI for the exact location?

DV: Right, he wants the rail dead on 2. All the rail, 1, 3 and 4.

DISPATCHER: Where exactly, Alex?

DV: Tarrytown. Tarrytown.

DISPATCHER: Tarrytown?

DV: Right.

16:21:50
DISPATCHER: Alex, ask if there's any injuries, if they're gonna need any ambulances.

DV: All right, I believe so. He says there's alot of people all over.

DISPATCHER: All right, the exact location is Tarrytown?

DV: That's right. He wants all emergency squads you can send, Bobby.

DISPATCHER: At Tarrytown?

DV: That's right.

DISPATCHER: Hello, OW.

OW: South of Tarrytown.

DISPATCHER: Tarrytown?

OW: South of Tarrytown.

DISPATCHER: Just east of Tarrytown. George, what's the exact location?

16:22:29
(no answer)

16:22:44
OW: He just east of Dobbs Ferry Station
DISPATCHER: Just east of Dobbs Ferry, right.

end 16:22:50

APPENDIX D

EXCERPTS FROM CONRAIL RULES OF THE TRANSPORTATION DEPARTMENT

Rule 281

FIG. A FIG. A-1

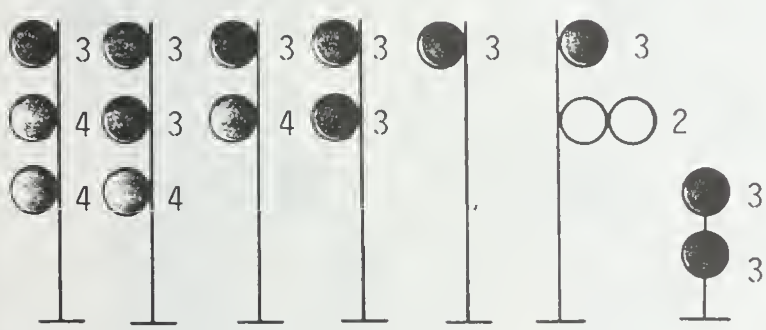


FIG. B FIG. B-1 FIG. B-2 FIG. B-3 FIG. B-4 FIG. B-5 FIG. B-6

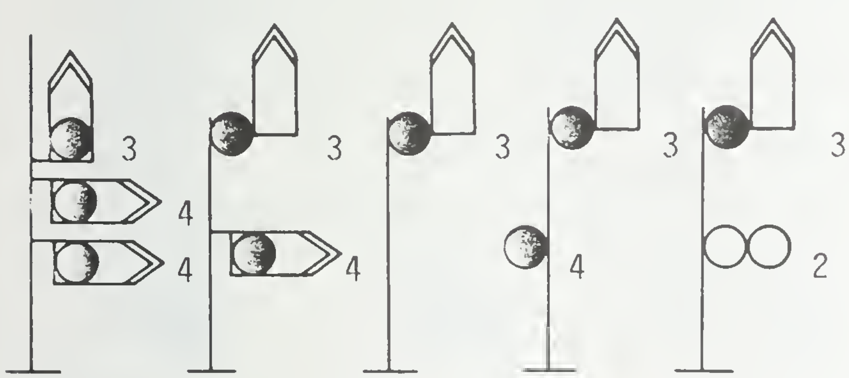
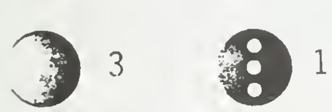


FIG. C FIG. C-1 FIG. C-2 FIG. C-3 FIG. C-4

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



INDICATION: Proceed.

NAME: Clear

Rule 282(A)

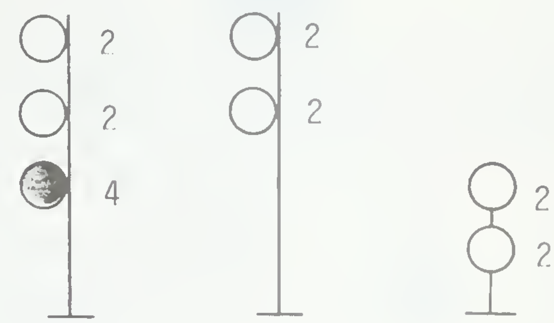
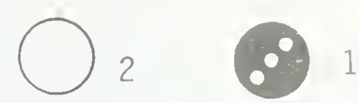


FIG. B FIG. B-1 FIG. B-2

IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



AND FIXED SIGNAL INDICATION WILL GOVERN

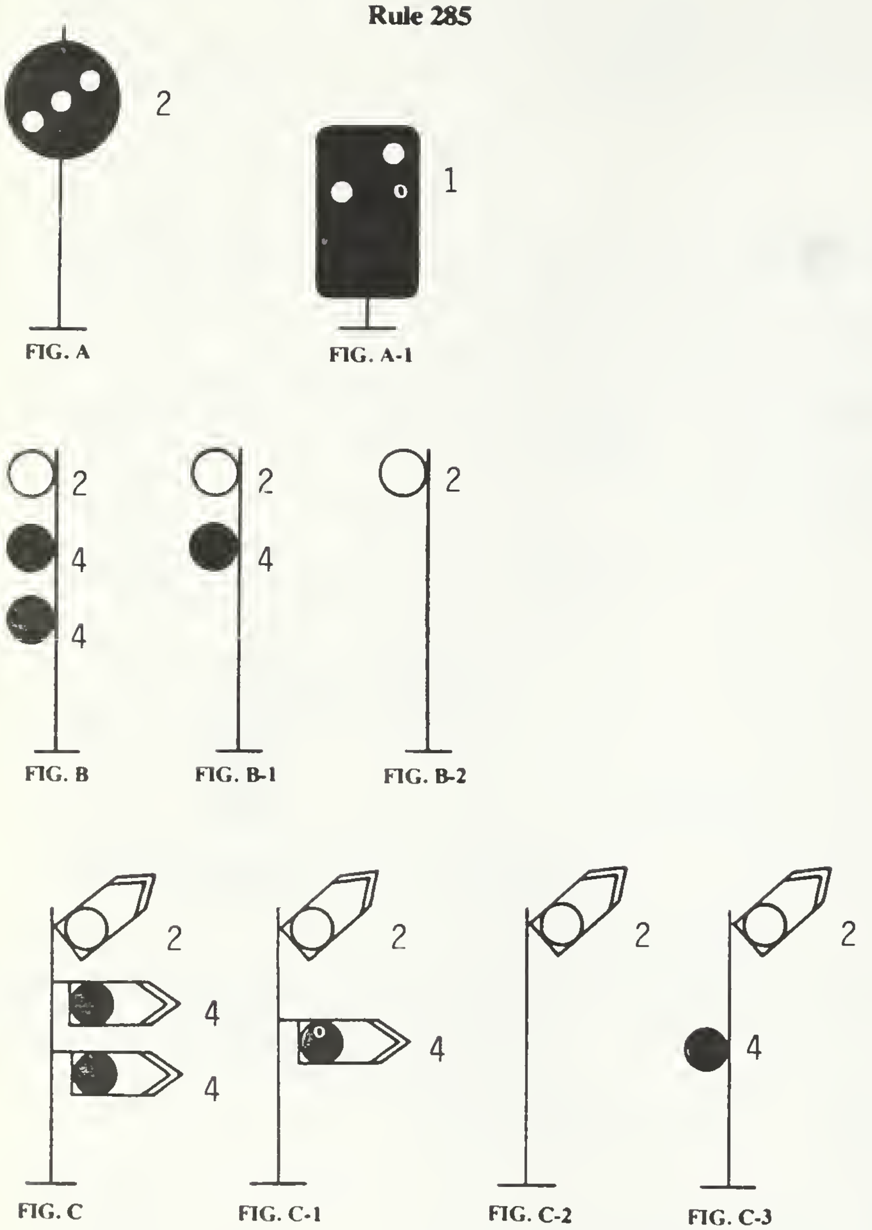
INDICATION: Proceed at Limited Speed prepared to stop at second signal. Reduction to Limited Speed must commence before engine passes Advance Approach signal.

NAME: Advance Approach

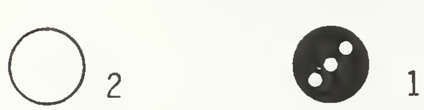
NTSB note:

1 indicates white
2 indicates yellow
3 indicates green
4 indicates red

Rule 285



IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



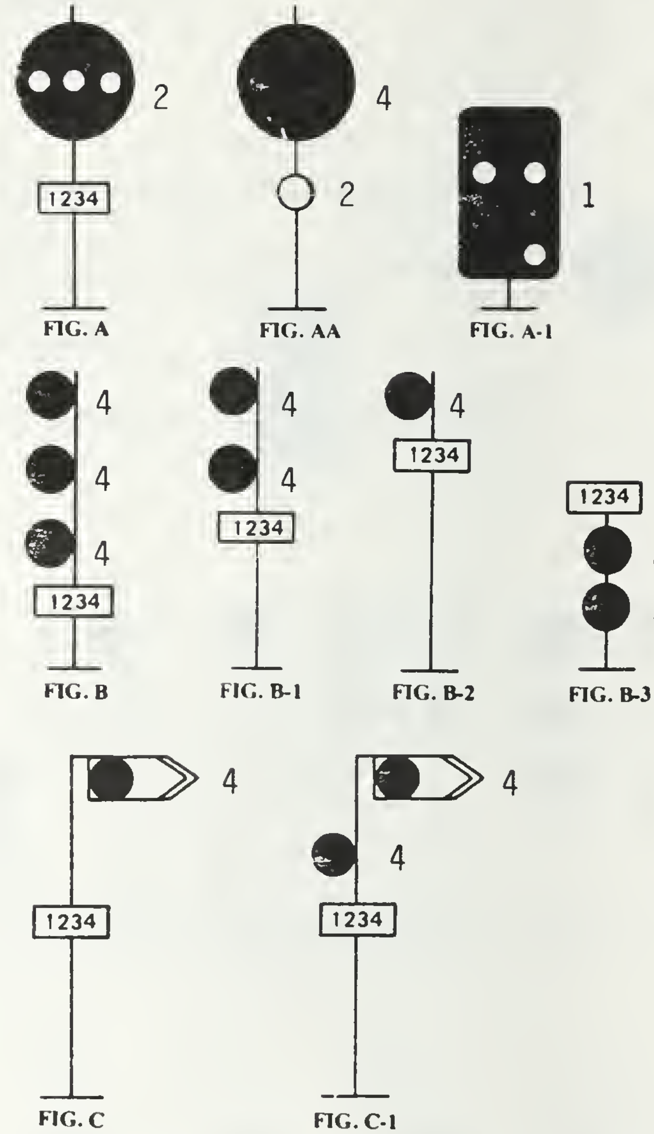
INDICATION: Proceed not exceeding Medium Speed prepared to stop at next signal. Reduction to Medium Speed must commence before engine passes Approach signal.

NAME: Approach

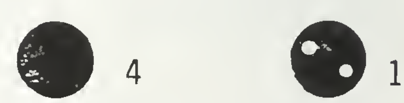
NTSB note:

1 indicates white
2 indicates yellow
3 indicates green
4 indicates red

Rule 291



IN CAB SIGNAL TERRITORY
CAB SIGNAL WILL DISPLAY



AND FIXED SIGNAL INDICATION WILL GOVERN

INDICATION: Stop; then proceed at Restricted Speed.

NAME: Stop and Proceed.

<u>**NOTE:**</u> Where, in addition to the number plate, a letter G, grade marker, is displayed as part of these aspects, Rule 290 applies.

APPENDIX E

EXCERPTS FROM CONRAIL TIMETABLE SPECIAL INSTRUCTIONS

SPEEDS
PASSENGER TRAINS AND FREIGHT TRAINS

1157-C1 Maximum Speeds, Unless Otherwise Specified

Hudson Line	Single Track Psgr.	Single Track Frt.	No. 4 Track Psgr.	No. 4 Track Frt.	No. 2 Track Psgr.	No. 2 Track Frt.	No. 1 Track Psgr.	No. 1 Track Frt.	No. 3 Track Psgr.	No. 3 Track Frt.	Other Track Psgr.	Other Track Frt.
Between	Miles Per Hour											
G.C.T. and U											10	10
U and Signals 103W, 101W, 102W, 104W Westward			15	15	15	15	15	15	15	15		
Signals 113E, 111E, 112E, 114E and U Eastward			15	15	15	15	15	15	15	15		
Signals 103W, 101W, 102W, 104W and MO Westward			35	35	35	35	35	35	35	35		
MO and Signals 113E, 111E 112E, 114E, Eastward			35	35	35	35	35	35	35	35		
MO Int. and FH Int			60	40	60	40	60	40				
FH Int. and DV Int					30	25	30	25				
DV Int and MP 14.3			75	40	79	40	79	40	60	40		
MP 14 3 and Glenwood Int			75	40	60	40	75	40	60	40		
Glenwood Int. and MP 23.0			75	40	60	40	79	40	60	40		
MP 23.0 and OW			60	40	60	40	79	40	60	40		
OW and MP 28.5			60	40	60	40	70	40	60	40		
MP 28.5 and CD			60	40	60	40	60	40	60	40		
CD and CP40			60	40	60	40	60	40				
CP40 and MP51.0					60	40	60	40				
MP 51.0 and MP 75 5					70	40	70	40				
MP 75.5 and MP 114.1					79	40	79	40				
MP 114.1 and MP 121.5					90	50	90	50				
MP 121.5 and MP 124.3					85	50	85	50				
MP 124.3 and MP 140.5					100	50	110	50				
MP 140.5 and CP 1					79	30	79	30				
CP 1 and CP 2	15	15										
CP 2 and CP 3	20	20										
CP 3 and CP 4					25	25	15	15				
CP 4 and Rock Cut			15	15			40	25				
Rock Cut and CP 5	80	30										
All Controlled Sidings											30	30

NOTE—75 MPH and 79 MPH in Third Rail Territory applicable to M-1, ACMU and TURBO TRAINS only

SPECIAL MAXIMUM SPEEDS

1157-C1b Trains with cars not equipped for passenger service must not exceed maximum speed for freight trains, unless otherwise instructed.

Trail-van trains, unless otherwise restricted, must not exceed maximum speed for freight trains.

1157-C2 Operating against the current of traffic, unless otherwise specified.

Hudson Line	Miles Per Hour Psgr.	Miles Per Hour Frt.
MO to CD	60	40
CP89 and Hud Int. (No. 1 Track)	70	40
R-94 and Hud Int. (No. 2 Track)	70	40
Rock Cut and CP4 (No. 4 Track)	15	15
MO to Div Post (N.E. Reg)	*15	*15

*At night over facing point hand operated switches where switch lights are not in use

1701-A1 Radio Operation

Radio on MU equipment is turned on by toggle switch located in Electrical Control compartment of car. Switch has three positions. Center position is off. Up or down position establishes operation of Radio from either Number 1 or Number 2 end of car. Hand microphone is fastened into the bottom of microphone holder box. Microphone button must be depressed to transmit and released to receive.

1702-A1 Road Train Radio Service

Hudson Train Dispatcher	Commuter Channel, Roads 1 & 2
Croton Yard Office	Road 2
Harmon Yard Office	Commuter Channel and Road 2
Albany-Rensselaer-Station Master	Road 1
LAB - Block Station	Road 1

1702-A2 Use of Radios

Conrail Road Radio channel 1, in operation between CP-75 and CP5.

Conrail Road Radio channel 2 in operation between CD and CP75

Metro Region Commuter Radio Channel 3, in operation between GCT and CD, GCT and Dover Plains and GCT and New Haven, including the New Canaan, Danbury and Waterbury Branches

1705-A1 In the application of **Rule 705**, Engineman or Conductor will make talking test of Radio to nearest Block Station when taking charge of equipment and before departure from Terminal other than G C T. When departing from G C T., talking test of Radio on Hudson Line trains will be made with DV, Harlem Line trains with Woodlawn and New Haven Line trains with Shell.

If radio does not operate properly, Engineman or Conductor will report defect to either Yardmaster or Car Foreman at terminal where train originates or terminates.

Only the Radio in operating end of MU trains will be turned on. If Conductor must use Radio elsewhere in train, he will turn Radio on in car he is occupying. It will be the responsibility of the Engineman to turn off Radio in Head or Operating car upon termination of run and the responsibility of the Conductor to know that Radios in all other cars in train are turned off.

APPENDIX F

EXCERPTS FROM 49 CFR 217 RAILROAD OPERATING RULES AND 49 CFR 220 RADIO PROCEDURES

Federal Railroad Administrator within 30 days after it is issued.

§ 217.9 Program of operational tests and inspections; recordkeeping.

(a) Each railroad to which this part applies shall periodically conduct operational tests and inspections to determine the extent of compliance with its code of operating rules, timetables, and timetables special instructions in accordance with a program filed with the Federal Railroad Administrator.

(b) Before March 1, 1975, or 30 days before commencing operations, whichever is later, each railroad to which this part applies shall file with the Federal Railroad Administrator, Washington, D.C. 20590, three copies of a program for periodic conduct of the operational tests and inspections required by paragraph (a) of this section. The program shall—

(1) Provide for operational testing and inspection under the various operating conditions on the railroad;

(2) Describe each type of operational test and inspection adopted, including the means and procedures used to carry it out;

(3) State the purpose of each type of operational test and inspection;

(4) State, according to operating divisions where applicable, the frequency with which each type of operational test and inspection is conducted;

(5) Begin within 30 days after it is filed with the Federal Railroad Administrator; and

(6) Include a schedule for making the program fully operative within 210 days after it begins.

(c) Each amendment to a railroad's program for periodic conduct of operational tests and inspections required under paragraph (a) of this section shall be filed with the Federal Railroad Administrator within 30 days after it is issued.

(d) *Records.* Each railroad shall keep a record of the date and place of each operational test and inspection performed in accordance with its program. Each record must provide a brief description of the operational test or inspection, including the characteristics of the operation tested or inspected, and the results thereof. Records must be retained for one year and made available to representatives of the Federal Railroad Administration for inspection and copying during regular business hours.

§ 217.11 Program of instruction on operating rules.

(a) To ensure that each railroad employee whose activities are governed by the railroad's operating rules understands those rules, each railroad to which this part applies shall periodically instruct that employee on the meaning and application of the railroad's operating rules in accordance with a program filed with the Federal Railroad Administrator.

(b) Before March 1, 1975 or 30 days before commencing operations, whichever is later, each railroad shall file with the Federal Railroad Administrator, Washington, D.C. 20590, three copies of a program for the periodic instruction of its employees as required by paragraph (a) of this section. This program shall—

(1) Describe the means and procedures used for instruction of the various classes of affected employees;

(2) State the frequency of instruction and the basis for determining that frequency;

(3) Include a schedule for completing the initial instruction of employees who are already employed when the program begins;

(4) Begin within 30 days after it is filed with the Federal Railroad Administrator;

(5) Provide for initial instruction of each employee hired after the program begins.

(c) Each amendment to a railroad's program for the periodic instruction of its employees required under paragraph (a) of this section shall be filed with the Federal Railroad Administrator within 30 days after it is issued.

Subpart B—Radio Procedures

§ 220.21 Railroad operating rules; radio communications.

(a) After August 1, 1977, the operating rules of each railroad with respect to radio communications shall conform with the requirements of this part.

(b) Before November 1, 1977 or 30 days before it commences to use radio communications in connection with railroad operations, whichever is later, each railroad shall file with the Federal Railroad Administrator, Washington, D.C. 20590, one copy of its operating rules with respect to radio communications. Each amendment to these rules shall be filed with the Federal Railroad Administrator within 30 days after it is issued.

§ 220.23 Publication of radio information.

Each railroad shall designate its territory where radio base stations are installed, where wayside stations may be contacted, and designate appropriate radio channels by publishing them in a timetable or special instruction. The publication shall indicate the periods during which base and wayside radio stations are attended or in operation.

§ 220.25 Instruction of employees.

Each employee who is authorized to use a radio in connection with a railroad operation, shall be:

(a) Provided with a copy of the railroad's operating rules governing the use of radio communication in a railroad operation.

(b) Instructed in the proper use of radio communication as part of the program of instruction prescribed in § 217.11 of this chapter.

§ 220.27 Identification.

(a) Except as provided in paragraph (c) of this section, the identification of each wayside, base or yard station shall include at least the following minimum elements, stated in the order listed:

(1) Name of railroad. An abbreviated name or initial letters of the railroad may be used where the name or initials are in general usage and are understood in the railroad industry;

(2) Name of office or other unique designation of the station; and

(3) Location of the station.

(b) Except as provided in paragraph (c) of this section, the identification of each mobile station shall consist of the following elements, stated in the order listed:

(1) Name of the railroad. An abbreviated name or initial letters of the railroad may be used where the name or initial letters are in general usage and are understood in the railroad industry;

(2) Train name (number), if one has been assigned, or other appropriate unit designation; and

(3) The word "engine", "caboose", "motorcar", "pakset" or other word which indicates to the listener the precise mobile transmitting station, unless identical to the requirement of paragraph (b)(2) of this section.

(c) If positive identification is achieved in connection with switching, classification, and similar operations wholly within a yard, fixed and mobile units may use short identification after the initial transmission and acknowledgement consistent with applicable Federal Communications Commission regulations governing "Station Identification".

§ 220.29 Statement of letters and numbers.

(a) If necessary for clarity, a phonetic alphabet shall be used to pronounce any letter used as an initial, except initial letters of railroads. See Appendix "A", of this part for the recommended phonetic alphabet.

(b) A word which needs to be spelled for precision or clarity shall first be pronounced, and the word shall then be spelled. If necessary, the word shall be spelled again, using a phonetic alphabet.

(c) Numbers shall be spoken by digit, except that exact multiples of hundreds and thousands may be stated as such. A decimal point shall be indicated by the word "decimal". (See Appendix B to this part, for a recommended guide to the pronunication of numbers.)

§ 220.31 Initiating a transmission.

Before transmitting by radio, an employee shall:

(a) Listen to insure that the channel on which he intends to transmit is not already in use;

(b) Identify his station in accordance with the requirements of § 220.27; and

(c) Verify that he has made radio contact with the person or station with whom he intends to communicate by listening for an acknowledgement. If the sation acknowledging his transmission fails to identify itself properly, the employee shall require a proper identification before proceeding with the transmission.

§ 220.33 Receiving a transmission.

(a) Upon receiving a radio call from another station, an employee shall promptly acknowledge the call, identifying his station in accordance with the requirements of § 220.27 and stand by to receive. An employee need not attend the radio, however, if this would interfere with other immediate duties relating to the safety of railroad operations.

(b) An employee shall acknowledge receipt of all transmissions directed to him or his station.

(c) An employee who receives a tansmission shall repeat it to the transmitting party unless the communication:

(1) Relates to yard switching operations;

(2) Is a recorded message from an automatic alarm device; or

(3) Is general in nature and does not contain any information, instruction or advice which could affect the safety of a railroad operation.

§ 220.35 Ending a transmission.

(a) At the close of each transmission to which a response is expected, the transmitting employee shall say "over" to indicate to the receiving employee that the transmission is ended.

(b) At the close of each transmission to which no response is expected, the transmitting employee shall state his identification followed by the word "out" to indicate to the receiving employee that the exchange of transmissions is complete.

§ 220.37 Voice test.

(a) Each radio which is used in connection with a railroad operaticn outside yard limits shall be tested at the point where the train is originally made up. At least once during each tour of duty, the engineer and conductor shall be responsible for the testing of the radio to verify that the radio is operating properly on the engine and caboose. The tests shall consist of an exchange of voice transmissions with another station. The other station shall advise the station conducting the test of the quality and readability of its transmission.

(b) Any radio found not to be functioning properly shall be removed from service until it has been repaired.

(c) When a radio is removed from service, each crew member of the train and the train dispatcher or other employee designated by the railroad shall be so notified.

§ 220.39 Continuous monitoring.

Engine and caboose radios must be turned on to the appropriate channel as designated in § 220.23 with the volume adjusted to receive communications while the engine or caboose is manned.

§ 220.41 Notification on failure of train radio.

The failure of an engine or caboose radio en route shall be reported as soon as practicable to the train dispatcher or other employee designated by the railroad by any alternate means of communication available.

§ 220.43 Communication consistent with rules.

Radio communication may not be used in connection with a railroad operation in a manner which conflicts with the requirements of this Part 220, Federal Communication Commission regulations or the railroad's operating rules. The use of citizen band radios for railroad operating purposes is prohibited.

§ 220.45 Communication must be complete.

Any radio communication which is not fully understood or completed in accordance with the requirements of Part 220 and the operating rules of the railroad, shall not be acted upon and shall be treated as though not sent.

§ 220.47 Emergencies.

(a) An emergency transmission shall be preceded by the word "emergency", repeated three times. An emergency transmission shall have priority over all other transmissions and the frequency or channel shall be kept clear

APPENDIX G

EXCERPT FROM RAIL SAFETY/EQUIPMENT CRASHWORTHINESS REPORT NO. FRA/ORD-77/73, IV

5. CONCLUSIONS

The conclusions reached in this study are based on data obtained from accident investigation reports and T-Forms, visual surveys of rail vehicle interiors, analytical determination of occupant impact forces and logical assumptions. Accident data, in the majority of incidents, reported the initiating factors of the accident, the type of vehicle the occupant was injured in and the nature of the injuries. The area of minimal information was on the injury mechanism or object contacted by the occupant. Conclusions as to the items requiring improvement to reduce injuries were based to a great extent on the visual surveys to determine the likely object to cause injury in a collision. This was particularly true for passenger rail vehicle occupants where collision injury mechanism data was practically non-existent. The severity of injuries, based on the assumptions from the visual survey, was determined by the use of mathematical analysis to obtain force levels.

Severity of injuries was found to be less pronounced for passenger railcar occupants than locomotive and caboose occupants. This is assuming that the passenger car does not telescope or become penetrated by an object. Calculations show that acceleration pulses experienced in passenger cars, regardless of the velocity at collision, should not cause occupants to impact interior furnishings at a velocity sufficient to cause fatal injuries. Injuries experienced in passenger cars fell into the minor to moderate level range. Modifications to passenger cars for collision safety will be for the purpose of eliminating or reducing injuries rather than so much to prevent fatalities. The principal modifications to passenger railcars are as follows:

- Prevent double seats from swiveling by providing a positive lock to improve occupant containment
- Prevent leg entrapment under seats by adding a back skirt to reduce high frequency of leg injury in collisions
- Provide padded armrests, headrests and shoulder wings to improve containment
- Provide padding on rigid bulkheads, doors and nonyielding partitions
- Compartment lounge and lavatory areas to minimize distance occupant can be thrown

APPENDIX H

STRUCTURAL TESTING - TRAILER CAR

VOM (Empty, Ready to Run) - Conducted May 26, 1975

Car Shell Weight	12,680	KG
Added Weight for VOM	17,363	KG
VOM	30,043	KG

Deflection - 2 MM on left side (looking aft)
1 MM on right side

VOM Plus Overload - Conducted May 27, 1975

VOM	30,043	KG
Overload	5,900	
	35,943	KG

Deflection - 3 MM left
2.5 MM right

Deflection is total from basic car shell weight of 12,680 KG

Camber was checked at VOM plus overload by means of a taunt wire strung between bolsters under center sill - plus 9.75 MM.

800K Compression Test - Conducted May 29, 1975.

Test results were not satisfactory - two different locations of strain gages showed readings up to 62.6 KG/MM^2 on material capable of 36 KG/MM^2. Location was in the tapered section of center sill at the base of the "H" coupler structure.

800K Test was reconducted June 13 after beef up of discrepant section. Test was successful. "B" end of power cars and both ends of trailer cars and food service cars, will represent this redesign.

500K Test was conducted June 18, 1975, and was successful.

Natural frequency test was conducted June 20, 1975.

Results are being clarified by AMF and will appear in official AMF test report.

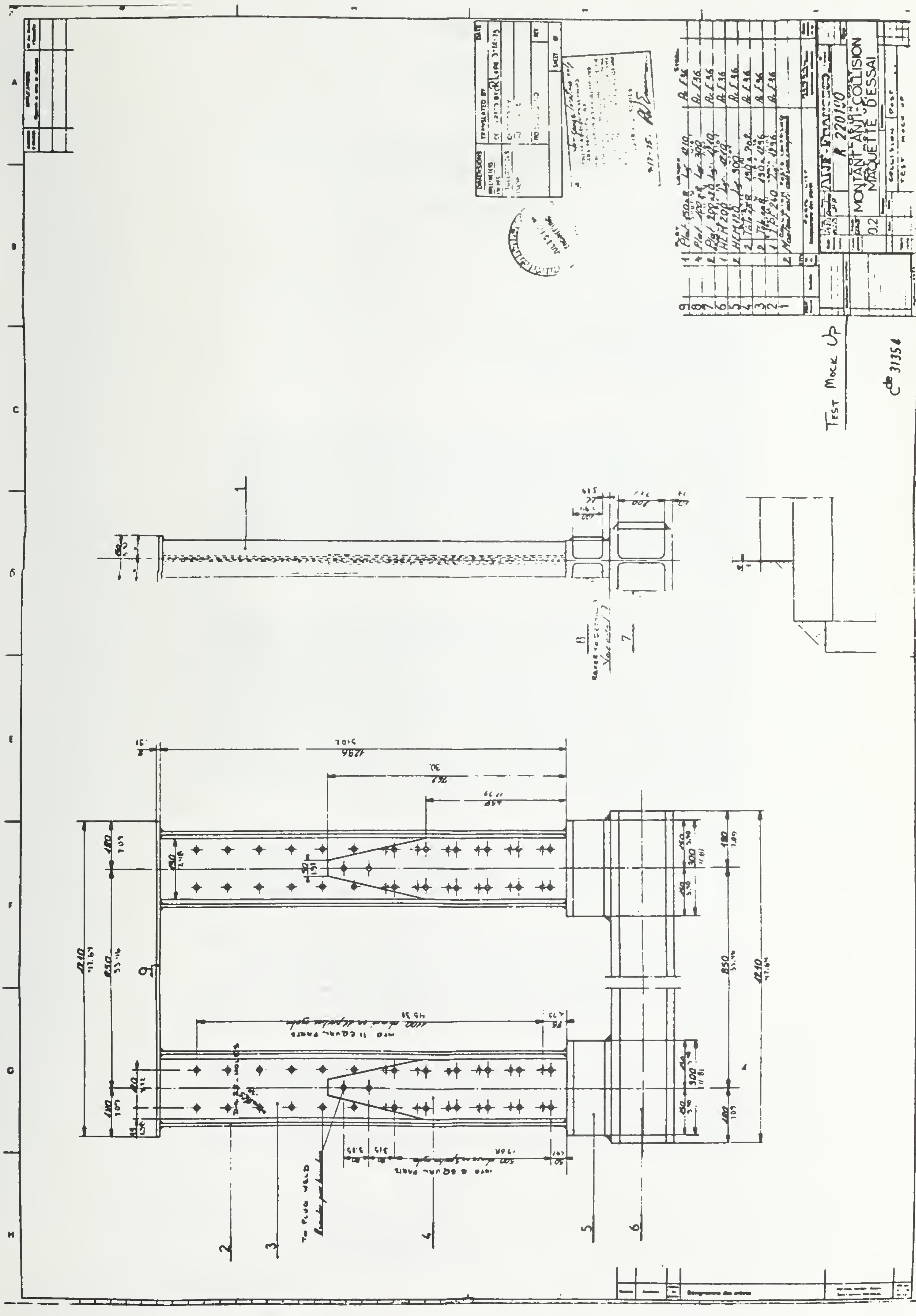
Structural Testing - Collision Posts

Test was conducted April 11, 1975.

Test was made on a mockup representing the two collision posts with the two posts facing each other and held together at the top and bottom with cross pieces.

A 150K load was applied 18" above lower attachment with no failure.

A 300K load was applied at the base with no failure.


MONTANT ANTI-COLLISION
MAQUETTE D'ESSAI
ANF-Frangeco
Test Mock Up
TO PLUG WELD

APPENDIX I

FRA LETTER

DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
WASHINGTON, D.C. 20591

OFFICE OF
THE ADMINISTRATOR

MAY 3 1971

Mr. John Reed
Chairman of the Board
National Transportation Safety Board
Federal Building
800 Independence Avenue, S. W.
Washington, D. C. 20591

Dear Chairman Reed:

During the years 1955-1968, inclusive, the Bureau of Railroad Safety has investigated approximately three hundred train accidents involving collisions where, in most instances, the control compartment (cab) of the locomotive, multiple unit commuter car as well as diesel-electric unit, was extensively damaged or destroyed, resulting in the death or serious injury of the cab occupants. In addition, during the same period, the Bureau has investigated more than two hundred accidents in which cab occupants have sustained injuries as the result of seat failures, insecure cab accessories, and defective cab floors, windows, and doors.

Of this type accident most recently investigated by the Bureau were those which occurred on the Southern Railway at Parrish, Alabama, on May 12, 1969, and at Leadville Junction, Tennessee, on October 26, 1969, and on the Penn Central at Wellington, Ohio, on August 18, 1969. In addition, a similar accident but involving commuter-type passenger carrying equipment which occurred on the Penn Central at Darien, Connecticut, on August 20, 1969, was investigated by the National Transportation Safety Board. A copy of the investigation report covering each of the foregoing accidents is enclosed for your ready reference. It should be noted that in each of these reports a reference is made to the design and location of the engineer's control compartment or to the application of a crash bar or other buffer device to the control compartment end of the locomotive.

We believe that this matter now warrants serious consideration with respect to recognizing the possibility and/or feasibility of effecting improvements in the design, location, and construction of control compartments not only to enhance the safety of cab occupants in the event of collisions or derailments, but to achieve an optimum environment under normal operating conditions.

Accordingly, we are hopeful of arranging an informal conference in this office at 2:00 p.m. on June 9, 1971, Conference Room No. 7234, which will be attended by representatives of locomotive and car builders, labor organizations, carriers, and the Association of American Railroads to discuss this matter with a view toward developing some meaningful and substantive proposals which will ultimately result in improving the safety of railroad operation.

It will, therefore, be appreciated very much if you will advise the undersigned at your earliest convenience if you desire to attend or to be represented at the subject conference. The Association of American Railroads is indeed welcome to invite the participation of appropriate carrier representatives, and we would welcome suggestions relative to extending invitations to others not included in this listing.

Sincerely,

Carl V. Lyon

Carl V. Lyon
Acting Administrator

Enclosures

U.S. GOVERMENT PRINTING OFFICE 1981-0- 341-828/26

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT OF
AMTRAK PASSENGER TRAIN NO. 21
ON THE ILLINOIS CENTRAL GULF RAILROAD
SPRINGFIELD, ILLINOIS
OCTOBER 30, 1980

NTSB-RAR-81-5

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-81-5	2. Government Accession No. PB81-217366	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report--Derailment of Amtrak Train No. 21 the Inter-American on the Illinois Central Gulf Railroad, Springfield, Illinois, October 30, 1980		5. Report Date April 28, 1981
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3142A
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Railroad Accident Report October 30, 1980
		14. Sponsoring Agency Code

15. Supplementary Notes

The subject report was distributed to NTSB mailing lists: 8A, 8D, 14A and 14B.

16. Abstract About 8:37 p.m., c.s.t., on October 30, 1980, two locomotive units and seven of eight cars of southbound Amtrak passenger train No. 21, the Inter-American, derailed while moving through a No. 10 main track turnout on the Illinois Central Gulf Railroad (ICG), at Springfield, Illinois. Of the 96 passengers and 12 train crewmembers on board, 4 passengers and 2 train crewmembers were injured. Both locomotive units and a sleeping car were overturned and incurred extensive damages. Total damage was estimated at $593,000.

The National Transportation Safety Board determines that the probable cause of this accident was the operation of Amtrak No. 21 into the No. 10 turnout at a speed significantly higher than the turnout's design speed, due to the failure of the train's engineer and fireman to perceive and comprehend that the color-light signal aspects displayed for their train indicated that it was to be routed through the 10-mph (No. 10) turnout. This failure resulted from the routine dispatching of passenger trains to avoid the turnout, the crew's lack of familiarity with the color-light type signal aspects, distraction of the enginemen, and the train speed exceeding the 25-mph restriction between the Springfield passenger station and Iles Tower. Contributing to the accident were ICG's poorly planned modifications to the signal and track systems at Iles and K.C. Junction, ICG's inadequate instruction of Alton District employees on the color-light signals, ICG's and Amtrak's failure to adequately monitor the performance of Alton District employees in passenger service, and the failure of the engineer of Amtrak No. 21 to wear eyeglasses as required.

17. Key Words Derailment, accelerating, single-main, diesel-electric, passenger train, other locomotive, CTC, signal compliance, speed control, signal aspects, crossing protection, signal systems, distraction, system safety, rules compliance, physical competence, supervision.	18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*

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CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: April 28, 1981

DERAILMENT OF AMTRAK TRAIN NO. 21 THE INTER-AMERICAN ON THE ILLINOIS CENTRAL GULF RAILROAD SPRINGFIELD, ILLINOIS OCTOBER 30, 1980

SYNOPSIS

About 8:37 p.m., c.s.t., on October 30, 1980, two locomotive units and seven of eight cars of southbound Amtrak passenger train No. 21, the Inter-American, derailed while moving through a No. 10 main track turnout on the Illinois Central Gulf Railroad (ICG), at Springfield, Illinois. Of the 96 passengers and 12 train crewmembers on board, 4 passengers and 2 train crewmembers were injured. Both locomotive units and a sleeping car were overturned and incurred extensive damages. Total damage was estimated at $593,000.

The National Transportation Safety Board determines that the probable cause of this accident was the operation of Amtrak No. 21 into the No. 10 turnout at a speed significantly higher than the turnout's design speed, due to the failure of the train's engineer and fireman to perceive and comprehend that the color-light signal aspects displayed for their train indicated that it was to be routed through the 10-mph (No. 10) turnout. This failure resulted from the routine dispatching of passenger trains to avoid the turnout, the crew's lack of familiarity with the color-light type signal aspects, distraction of the enginemen and the train speed exceeding the 25-mph restriction between the Springfield passenger station and Iles Tower. Contributing to the accident were ICG's poorly planned modifications to the signal and track systems at Iles and K.C. Junction, ICG's inadequate instruction of Alton District employees on the color-light signals, ICG's and Amtrak's failure to adequately monitor the performance of Alton District employees in passenger service, and the failure of the engineer of Amtrak No. 21 to wear eyeglasses as required.

INVESTIGATION

The Accident

About 7:32 p.m., October 30, 1980, southbound Amtrak passenger train No. 21, consisting of two locomotive units and eight cars, arrived at Bloomington, Illinois, on the tracks of the Illinois Central Gulf Railroad (ICG). The arriving engineer informed the relieving engineer that the only problem with the train was that the locomotive's crew alerter device was not functioning. No. 21 departed Bloomington at 7:34 p.m., 4 minutes behind schedule, en route to St. Louis, Missouri, and Laredo, Texas. When the train's speed reached 55 miles per hour (mph), the engineer made a running test application of the brakes and was satisfied that they functioned properly. The engineer also stated that

he made a speed indicator check at the maximum authorized speed of 79 mph at a location about 11 miles south of Bloomington. According to the engineer, the check showed that the indicated speed was about 3 mph greater than the actual speed.

Except at Lincoln, Illinois, which is a scheduled stop, and at two locations where a general order restricted speed to 60 mph for short distances, passenger trains were allowed a maximum speed of 79 mph in the 56.3 miles between Bloomington and Ridgely Yard, located 2 1/2 miles north of the passenger station at Springfield, Illinois. Other than when accelerating or decelerating, No. 21 was operated at speeds between 80 and 88 mph over this section of track. The train's speed was reduced to about 60 mph for the first general order restriction and to about 50 mph for the second restriction. When No. 21 arrived at the Springfield passenger station (see appendix G) at 8:28 p.m., it was "on time."

ICG Extra 8002 South (SGV3-29), a 74-car southbound freight train, departed Ridgely Yard at 8:09 p.m., 14 minutes before No. 21 reached that location. Extra 8002 South passed Iles Tower, 2.15 miles south of the Springfield passenger station, at 8:24 p.m. The engineer used his radio to call out the "clear" aspect displayed by the train order signal board at Iles, and this transmission was heard by his conductor and the fireman of Amtrak No. 21. The engineer of No. 21 stated that he did not hear the transmission and was unaware that Extra 8002 South had departed from Springfield ahead of his train.

Shortly after Amtrak No. 21 left the Springfield station, the conductor learned that a passenger who had wished to get off failed to do so. The conductor transmitted a "stop-at-once" indication over the train communicating signal to which the engineer responded by applying the train brakes. The head end of Amtrak No. 21 stopped about 0.6 mile south of the station and about one-half mile north of the next intermediate block signal at South Grand Avenue, which displayed a "clear" aspect. After the conductor signalled the engineer to proceed at about 8:34 p.m., the engineer used full throttle to rapidly accelerate the train, which passed the signal at South Grand Avenue at a speed of about 45 mph.

The dispatcher stated that he intended to have No. 21 overtake Extra 8002 South after it departed Springfield on a 1.7-mile section of double track between K. C. Junction and Hazel Dell. He encoded the Centralized Traffic Control (CTC) machine to route Extra 8002 South on track No. 1, to hold the train at Hazel Dell, and to reverse the turnout at the north end of the double track at K. C. Junction to track No. 2 after Extra 8002 South passed. According to the engineer of Extra 8002 South, the home signals at Iles and K. C. Junction displayed "clear" and "approach" aspects, respectively, for his train, and his conductor stated that the K. C. Junction home signal displayed a "stop" aspect when his caboose passed it. When Extra 8002 South stopped short of the "stop" aspect displayed by the home signal at Hazel Dell, the rear end of the train was about 3,600 feet south of the north end of the double track section at K. C. Junction. After Extra 8002 South cleared the turnout at K. C. Junction, the switch automatically reversed as encoded so that it was aligned to track No. 2 for train No. 21. The dispatcher stated that he had given Extra 8002 South the straight route since moving this relatively long train through the 10-mph turnout at K. C. Junction would have taken so much time that No. 21 was sure to have been stopped and delayed as a result. The decision to route No. 21 through the 10-mph turnout was made before No. 21 was delayed while discharging the passenger south of the Springfield station.

Iles Tower is a two-story structure located west of the ICG main track and between the ICG's crossings of the Norfolk & Western Railway (N&W) and Iles Avenue. Iles Avenue is a two-lane east-west thoroughfare and its crossing of the ICG is protected by automatic flasher lights and a bell alarm. Due to track curvature, the engineer's view of the Iles Avenue grade crossing was partially masked by Iles Tower and foliage on the inside of the curve until the locomotive of No. 21 was about 700 feet from the grade crossing. According to the engineer, the home signal at Iles and the train order signal at Iles Tower displayed "clear" aspects. The engineer used the radio to report the train order signal aspect to the conductor and flagman who were in the middle of the train at the time. The engineer stated that an auto was on the crossing, but after continuous blowing of the locomotive whistle, the auto was backed off the track. The engineer of No. 21 did not initiate braking, and the train was still accelerating as it passed Iles Tower at 57 mph.

According to the engineer of Amtrak No. 21, the home signal at K. C. Junction, 2,903 feet south of Iles Tower, displayed a yellow-over-green-over-red "approach limited" aspect, indicating that his train was to be routed over the straight route to Hazel Dell, then through the 30-mph turnout at the end of the double track section. Although the fireman later corroborated the engineer's statement regarding the signal aspects, he was at first uncertain as to the aspects displayed for No. 21, and he admitted that he did not call out the aspects as required by ICG rule 34. (See appendix C.) Further, the fireman's statements indicated that neither he nor the engineer were aware of the impending accident until their locomotive entered the turnout to track No. 2. Still accelerating, Amtrak No. 21 was moving at 63 mph when it derailed in the turnout at 8:37 p.m.

Injuries to Persons

Injuries	Passengers	Crewmembers and Service Personnel	Total
Fatal	0	0	0
Nonfatal	4	2	6
None	92	10	102
Total	96	12	108

Damage

After derailing, the lead locomotive unit traveled about 400 feet south before turning into a level cornfield east of the track. When nearly perpendicular to the track, the unit turned over on the right side with the carbody separated from the trucks. The right side wall and the right side of the roof of the operator compartment were crushed inward, both halves of the windshield and the right side window were broken out, the fireman's seat was pulled out of the floor, and the right side door was unhinged and driven inward. The unit also had frame damage and most of the panel doors on the right side were caved in. The trailing locomotive unit, which also stopped in the cornfield perpendicular to the tracks and immediately north of the lead unit, turned over on its side with the carbody separated from the trucks. The operator compartment roof was crushed inward when it struck the rear truck of the lead unit. Both couplers were sheared off, the fuel tank was ruptured, and there was extensive damage to the frame, side panel doors, and the pilot. The first three cars of No. 21, a baggage car, sleeper, and a cafe car, respectively, became separated from each other and the rest of the train. The baggage car followed the locomotive into the cornfield and stopped nearly parallel to the tracks

and east of the locomotive units. It remained upright and was not untrucked. The sleeper carbody came to rest on its left side diagonally across both tracks immediately north of the trailing locomotive unit. The left carside, trucks, couplers, and underfloor apparatus were damaged. The cafe car remained upright but also straddled the tracks diagonally immediately north of the sleeper. The remaining five cars remained coupled together and in line on track No. 2 alignment. All but the last car were derailed, but as with the cafe car, damage was confined to the wheels and other truck components.

About 450 feet of track No. 2 and 150 feet of track No. 1 were destroyed, and it was necessary to replace the frog in the turnout where the derailment occurred. The northbound home signal for track No. 2 and some underground power cables for the signal system were also destroyed.

Damage was estimated as follows:

Locomotive units	$500,000
Passenger cars	58,000
Track	20,000
Signal apparatus	5,000
Total	$593,000

Crewmember Information

The engineer and fireman were regularly assigned to Amtrak No. 21 and northbound Amtrak No. 22 between St. Louis, Missouri, and Bloomington, Illinois, and had shared the assignment for about 2 months prior to the accident. (See appendix B.) Neither man could recall any time during that period when he had not worked the assignment. Their usual tour of duty lasted 3 to 3 1/2 hours and the schedules of the trains were so arranged that they could sleep and eat their meals at conventional times. Their normal time off duty when at their home terminal of Bloomington was about 36 hours. On October 29, 1980, the engineer and fireman had left St. Louis on No. 22 about 8:45 a.m., and arrived at Bloomington at 1:30 p.m., 1 hour 53 minutes late. Both stated they had a normal bed rest of 8 to 9 hours during the night and arose at about 7:00 a.m. on the 30th. The engineer recalled that he had done some banking and shopping during the day; the fireman said he had spent the day visiting a friend and his mother. Both men ate supper before reporting for duty at 7:25 p.m. The conductor and flagman reported at the same time and had been off duty the previous 23 1/2 hours.

It was the regular practice of the enginemen to have the engineer operate No. 21 for the 97 miles from Bloomington to Carlinville, Illinois, and for the fireman who was a qualified engineer, to operate the train the remaining 60 miles to St. Louis. The men reversed the procedure on the return run to Bloomington.

At the time of the accident, the ICG required that the engineer wear corrective bifocal eyeglasses at all times when on duty to correct a deficiency in his ability to see at a distance. (See appendix B.) The engineer also stated that he needed to wear the glasses to read and had difficulty making out the numbers on the speed indicator without his glasses. He also said he had only one pair of bifocals which he obtained at the time he was restricted by the railroad. Shortly after the accident, the engineer stated that he could recall wearing the glasses to read the clearance, train orders, and the general order given to him when he reported for duty at Bloomington, but was uncertain whether or not

he had worn them after that time. The engineer later insisted that he was wearing the glasses at the time of the accident and that, as a result, the glasses had been nicked and scuffed.

After the accident an assistant superintendent searched the cab for the crewmembers' personal effects. He found only the fireman's timebook and the unopened and relatively undamaged grips belonging to the enginemen. These items were taken to the division offices at Bloomington for safekeeping. The clearance form, train orders, and a general order issued to the engineer at Bloomington, wrapped together around a carrying case holding a pair of undamaged bifocal glasses, were found inside a compartment in the engineer's grip. The glasses and case were returned to the engineer the day after the accident. On November 2, 1980, Safety Board investigators examined the glasses in the presence of the engineer and found them to be free of damage.

When questioned after the accident, the engineer of Amtrak No. 21 stated that a passenger train engineer was primarily responsible for operating his train on schedule and that to do so he might have to exceed authorized speed. He also complained that the numbers on the speed indicator ought to be larger so that he could read them without wearing his eyeglasses. In his sworn testimony to Safety Board investigators, the engineer of Amtrak No. 21 was unable to correctly state the color-light aspect which was displayed at K. C. Junction for a train routed to track No. 2, and he was confused as to which aspects would be displayed at Iles for trains routed through the diverging routes at K. C. Junction. He also stated that 35 mph was the permissible speed through the 30-mph turnout at Hazel Dell.

During a videotaped interview by a Champaign, Illinois, television station the day after the accident, the engineer of Amtrak No. 21 twice stated that had he known his train was routed through the turnout at K. C. Junction, he would have had the train moving at 30 mph instead of 60 mph. The same statement was later accredited to the engineer by the Bloomington newspaper. The engineer later denied making the statements.

Train Information

Amtrak No. 21 was assembled on October 30, 1980, at Chicago, Illinois, and consisted of two locomotive units and eight cars. The lead locomotive unit and all of the cars except the baggage car had been used the previous day between Temple, Texas, and Chicago in train No. 22. Before leaving Chicago Union Station at 5:20 p.m., No. 21 had received the required inspection and initial terminal brake test. No exceptions were taken during the inspection and testing.

The locomotive of No. 21 consisted of two General Motors model F40PH 3,000-horsepower units delivered to Amtrak in 1978. The units were equipped with 4-wheel trucks, type-F couplers, type-26L air brake equipment, radio, speed indicator, speed recorder, overspeed control, and an electronic crew alerter device. The alerter device in the lead unit was inoperative from the time No. 21 left Chicago.

The train consisted of a baggage car, sleeper, cafe car, coach, cafe car, and three coaches, respectively from the head end. The sleeper had 6 bedroom compartments on one end and 10 roomette compartments, arranged 5 on each side of a center aisle, on the other end. This car had been upgraded at Amtrak's Beech Grove, Indiana shop in

July 1980. The cafe cars and coaches were of the new "Amfleet" design. All cars in the train had 4-wheel trucks, type-H "tight-lock" couplers, and self-contained emergency lighting systems. A communicating signal line was connected and functional throughout the train. In addition, the flagman had been furnished a small portable radio for communications with the engine crew.

Method of Operation

The line involved in the accident was the north-south Alton District of ICG's St. Louis-Missouri Division. Prior to August 1972, this was the main line of the Gulf, Mobile and Ohio Railroad (GM&O). Trains are operated over the Alton District by the signal indications of a Centralized Traffic Control system operated by a dispatcher at Bloomington. Train crews are also directed in their duties by radio-transmitted instructions from the dispatcher.

ICG St. Louis-Missouri Division Timetable No. 4, dated August 3, 1980, was in effect at the time of the accident. At the time, three Amtrak passenger trains operated over the Alton District each way daily. The timetable authorized 79 mph and 50 mph as the maximum permissible speeds for passenger and freight trains, respectively, except at locations where other speed restrictions were in effect. The following speed restrictions were in effect for passenger trains at the time of the accident: 15 mph from the Springfield passenger station to Capitol Avenue, 1/ (about 0.2 mile); 25 mph from Capitol Avenue to Laurel Street (slightly over 1 mile); 60 mph over the N&W crossing at Iles; 10 mph through diverging turnouts at K. C. Junction; and 30 mph through all other diverging remotely-controlled CTC turnouts between Bloomington and Carlinville. When the engineer and conductor of Amtrak No. 21 reported for duty at Bloomington, they were given a general order which covered five speed restrictions and four train orders, two of which covered temporary speed restrictions and one which annulled one of the speed restrictions covered by the general order. None of the remaining order restrictions applied to the territory between the Springfield passenger station and Hazel Dell. (See appendix D.)

Illinois Central Gulf operating rule 34, as amended on January 1, 1978, requires all employees located in the operating compartment of a locomotive to communicate "when practicable" with each other in an audible and clear manner the name or aspect of each signal affecting movement of their train as soon as they can clearly see the signal. The rule also requires crewmembers who are aware of the engineer's failure to comply with a signal, and who have communicated with him without receiving the proper response, to protect the train by taking action which may include opening the emergency brake valve. (See appendix C.)

According to the fireman of Amtrak No. 21, it was his custom and the engineer's to call out only restrictive signal indications. ICG does not formally require its engineers to check the accuracy of locomotive speed indicators, and the St. Louis-Missouri Division timetable does not show any designated test miles for making such checks. However, the former GM&O had designated the track between mileposts 137 and 138 south of

1/ The timetable does not give milepost references for the Springfield street locations where the allowable speed changes. There are no speed restriction signs, or signs identifying the streets on the ICG right-of-way.

Bloomington as a southbound test mile. A sign erected north of milepost 137 identified the location as a test mile and this was still in place on October 30, 1980.

The Safety Board's investigation found that whenever possible the dispatchers routed trains operating in both directions through the 30-mph turnout at Hazel Dell rather than through the 10-mph turnout at K. C. Junction. The dispatchers estimated that as few as 5 to 10 percent of the trains were routed through the 10-mph turnout. The fireman of No. 21 could not recall a single occasion when his train was routed through the 10-mph turnout and the engineer thought he had been routed that way on only one occasion.

Iles Tower is a manually-operated interlocking plant manned continuously for ICG and Norfolk and Western Railway (N&W) by operators who are employees of N&W. ICG also uses Iles Tower as a continuously-operated train order station. The operator could communicate with the dispatcher at Bloomington by the dispatcher's telephone line. However, the operator was not furnished an ICG radio. N&W required the operator to inspect N&W trains as they passed from a ground location outside the tower. ICG permitted the operator to observe ICG trains from inside the second floor office area of the tower.

Track, Signal, and Crossing Information

Formerly, the Alton District from Bloomington southward to Springfield, Iles, and beyond was a double-track main line with automatic block signals. By 1972, the GM&O had changed most of this territory to single track under Centralized Traffic Control. The change was made by removing one main track except for short sections which were utilized as passing tracks. No. 20 turnouts with dual control power switches were installed at the ends of all the passing tracks. The only remaining double-track section was the 6.6 miles between Ridgely Yard, on the north side of Springfield, and Hazel Dell (then known as Iles South). The southbound main track was terminated at Iles South and was connected to the northbound main track with a No. 20 turnout. At this time, all of the signals on the Alton District were of the approach-lighted color-position type.

The single-track Air Line District to Kansas City formerly left the southbound Alton District main track by way of a right-hand turnout at Iles tower. During 1975-1976, ICG made some substantial track and signal changes at Iles in order to give trains moving over the former Illinois Central main line, which parallels the Alton District to the east, access to the Kansas City line. This was accomplished by moving the Kansas City turnout to a point on the southbound main track 3,070 feet south of Iles Tower, retiring the northbound main track between the N&W crossing and the new junction, and placing the southbound main track between those points under CTC. A No. 10 turnout with power switch was installed to connect the southbound main track with the remaining section of the northbound main track. Opposing home signals of the continuous-lighted color-light type used on the former Illinois Central were installed on both sides of the new junction. The southbound home signal consisted of three signal heads mounted on a vertical mast west of the main track.

Coincident with the track changes, the southbound and northbound main tracks between the new junction and Iles South were redesignated tracks No. 1 and No. 2, respectively. The new junction was initially called Iles and the old Iles interlocking was renamed N&W Crossing interlocking. (See figure 1.) Early in 1976, ICG completed the new access line from former Illinois Central trackage adding a third No. 10 turnout at the

Figure 1.—View from southbound train approaching the home signal and tower at Iles. Iles Avenue crossing is beyond the tower.

new Iles interlocking. Later in 1976, the southbound home signal for the N&W crossing was changed to continuous-lighted color-light type with two signal heads on a mast to the west of the southbound main track. (See figure 1.) Finally, at the end of 1978, the northbound main track from N&W Crossing interlocking to Ridgely Yard was removed and the former southbound main track was placed under CTC.

The new Iles interlocking was renamed K. C. Junction early in 1976. Later ICG restored the old designation of Iles to the N&W Crossing interlocking and changed the name of Iles South to Hazel Dell. The various name changes reportedly caused much confusion among employees and supervisors. This was evident from the wording of operating bulletins issued to cover the changes. (See appendix E.) During the Safety Board's investigation, the engineer of Amtrak No. 21 twice referred to K. C. Junction as Iles South, a senior signal supervisor several times referred to Hazel Dell as Iles South, and other employees and supervisors were heard to misname the various locations.

When Amtrak No. 21 made its last stop at Springfield, the approximate location of the locomotive was milepost 185.7, slightly more than one-half mile south of the Springfield passenger station and about 2.2 miles north of the left-hand turnout to track No. 2 at K. C. Junction. For the first 1.3 miles, the single main track was tangent. For the remaining .9 mile to the turnout, the track was in a 0° 30' curve to the right southbound. Superelevation throughout this curve varied from 1 1/4 inch to 1 1/2 inch. Beginning at milepost 185.7, the gradient southbound was 0.65 percent ascending for 0.1 mile, then 0.17 percent ascending for 0.6 mile. From milepost 186.4 to the accident location the grade was level. The permitted speeds of trains required the track to be maintained to the Federal track safety standards for Class 4 track.

The derailment occurred on the turnout side of a No. 10 left-hand facing point switch built of 115-pound jointed rail with 16-foot, 6-inch Sampson switch points and a No. 10 frog. The first mark on top of the rail was 36 feet 10 1/2 inches behind the turnout switch point. Cross level was 2 inches low at the switchpoint, 1 1/2 inches low at the heel of the switchpoint, and 1 1/2 inches low at the point of derailment, on the right-hand rail.

The southbound color-light type home signals at Iles and K. C. Junction were installed during 1975 and 1976 and were arranged to display three different combinations of aspects, one combination for each of the three routes a southbound train could take at K. C. Junction. The Iles-K.C. Junction section was the only location on the Alton District where these aspect combinations could be displayed. Gulf, Mobile and Ohio had adopted an advanced design of color-position signal (see appendix C), the aspects of which were radically different than those of the IC color-light signals. On October 30, 1980, the former GM & O color-position signals were still in use throughout the Alton District except at Iles and K. C. Junction.

The three-aspect color-light combinations that could be displayed at Iles and K. C. Junction and the routes they governed were as follows:

If the dispatcher had encoded the route for a southbound train to take the diverging Air Line District Route toward Kansas City by way of the right-hand facing-point turnout, the following aspects should have been displayed by the southbound home signals:

Home Signal at Iles

Rule No.	Aspect	Name	Indication
284	Yellow-over-yellow	Medium approach	Proceed: approaching next signal prepared to enter turn out at prescribed speed (10 mph as per timetable) but not exceeding 30 mph

Home Signal at K. C. Junction

Rule No.	Aspect	Name	Indication
288	Red-over-red-over-green	Slow clear	Proceed: at prescribed speed within interlocking limits or through turnout (10 mph as per timetable)

With the turnouts at K. C. Junction aligned for straight movement over track No. 1 but with the turnout at Hazel Dell aligned for movement through the turnout from track No. 1 to track No. 2, the route the engineer of No. 21 thought he was taking, the following aspects should have been displayed by the southbound home signals:

Home Signal at Iles

Rule No.	Aspect	Name	Indication
281	Green-over-red	Clear	Proceed

Home Signal at K. C. Junction

Rule No.	Aspect	Name	Indication
283	Yellow-over-green-over-red	Approach limited	Proceed: approaching next signal prepared to enter turnout at prescribed speed, (30 mph) but not exceeding 40 mph.

With the left-hand facing-point turnout at K. C. Junction aligned for movement through the turnout to track No. 2 and the turnout at Hazel Dell aligned on the straight route from track No. 2, the route the dispatcher coded for No. 21, the home signals should have displayed the following aspects:

Home Signal at Iles

Rule No.	Aspect	Name	Indication
283	Yellow-over green	Approach limited	Proceed: approaching next signal prepared to enter turnout at at prescribed speed, (which was 10 mph) but not exceeding 40 mph.

Home Signal at K. C. Junction

Rule No.	Aspect	Name	Indication
286	Red-over-green over-red	Diverging clear	Proceed on diverging route; not exceeding prescribed speed through turnout (which was 10 mph at K. C. Junction)

The train order signal at Iles Tower was of the lighted semaphore type with day and night aspects displayed for the indications "stop" and "proceed." The day aspect for "proceed" was the semaphore blade displayed vertically in the upper quadrant; the night aspect was a green light. The day aspect for "stop" was the semaphore blade displayed on a horizontal axis; the night aspect was a red light. The Illinois Central Gulf Railroad Rules provide for the following train order signal aspects.

Rule No.	Aspect	Name	Indication
297	Red light; horizontal semaphore blade	Stop	Stop; unless clearance received
298	Green or yellow light;diagonal semaphore blade in lower quadrant	Clear	Proceed

However, the timetable in effect included a modification to the rules which acknowledged that train order signals at some locations display the "proceed" aspect by having the semaphore blade inclined vertically upwards.

Prior to July 25, 1977, the rail/highway grade crossing of Iles Avenue and ICG was protected by flashing lights and gates manually operated by the Iles Tower operator. These devices were replaced with automatic flashers and a bell alarm mounted on short masts on each side of the crossing. This change was coordinated with reconstruction of the horizontal and vertical approaches of Iles Avenue to the crossing and relocation of the crossing itself slightly to the south of the original alignment. All of the changes were ordered by the Illinois Commerce Commission (ICC) in December 1975. A count of more than 19,000 motor vehicles using the crossing in a 24-hour period was tallied by ICC on April 1, 1975.

On October 31, 1980, Safety Board investigators observed traffic over the Iles Avenue crossing between 8:00 p.m. and 9:00 p.m. During this period, the flow of vehicles was virtually constant in both directions with traffic frequently stopping on the crossing due to congestion at intersections east and west of the crossing. Subsequent observations revealed that many motorists ignored the flashers and bell as well as the warning whistles of trains approaching the crossing. (See figure 2.)

Meteorological Information

At the time of the accident it was clear and dry. There was no atmospheric restriction to ground visibility. The temperature was 37° F, and winds were southwesterly at 10 mph.

Medical and Pathological Information

Four passengers were taken to Springfield hospitals. Three passengers had minor injuries and the fourth passenger, a pregnant woman, had no apparent injury but was taken to the hospital as a precaution. None of the passengers were hospitalized. Of the crewmembers, the fireman, who had injuries to both knees and the neck, was hospitalized. The engineer, who had multiple bruises and lacerations, was released after outpatient treatment. Postaccident toxicological examinations of the engineer and fireman were negative for alcohol and drugs.

Survival Aspects

Except the sleeper, which sustained extensive underfloor damage to the electrical system, the emergency lighting system of each car functioned as intended after the accident.

Figure 2.--Alton Division main track viewed facing north, showing southbound approach to N&W crossing and Iles Tower. Iles Avenue crossing is in the foreground.

The conductor and flagman were in the fourth head car at the time of the derailment. The flagman used the small portable radio he had been furnished to transmit a "Mayday" call for emergency assistance. He also tried unsuccessfully to contact the enginemen. The "Mayday" alert was monitored by the engineer and conductor of Extra 8002 South and by the night yardmaster at Ridgely Yard. The yardmaster promptly notified the Springfield-Sangamon County Rescue Squad, and emergency personnel began arriving on scene about 15 minutes after the accident. The crew of Extra 8002 South responded by backing their train so that the caboose was in the vicinity of the derailed passenger train. The conductor then took a lantern and went to assist the crew of No. 21. After notifying the dispatcher and receiving his permission, the freight train crew detached their locomotive, moved to track No. 2 through the turnout at Hazel Dell, and backed down to the derailment area. The locomotive's rear headlight was then used to effectively illuminate the area during the rescue and evacuation operations.

The conductor of Amtrak No. 21 had more than 14 years of emergency training and experience as a volunteer fireman in his home community. While the flagman was summoning help, the conductor went forward to the lead coach, checked for injured persons, calmed several passengers, including children, and then led and assisted the passengers to the rear of the train where he thought they would be the safest until help arrived. The conductor then went to the overturned and unlighted sleeper where he found all eight passengers trapped in their compartments, unable to open the doors. With the help of the sleeping car porter, the conductor managed to open all the compartment doors and evacuated the passengers from the car.

The engineer was pinned between his seat and the control stand in the locomotive cab. The fireman was laying unconscious behind the back of the control stand. The first person to attempt to help the engineman was a man who lived next to the tracks on a dead-end street south of the derailment site. He was later joined by the baggagemaster, the conductor, and a male nurse who had been a passenger on the train. After rescue squad members arrived, the fireman regained consciousness and was helped out of the cab. About 1 1/2 hours after the accident, rescuers finally succeeded in freeing the engineer. (See figure 3.)

After emergency forces arrived on the scene and the locomotive of Extra 8002 South illuminated the accident area, the passengers were evacuated to the dead-end street. (See figure 4.) The resident who had tried to free the enginemen opened his home to the passengers, crewmembers, and emergency personnel. Ultimately, the passengers were transported by Springfield Mass Transit District buses to the Springfield passenger station where they were sheltered until Amtrak could arrange bus transportation to St. Louis.

Postaccident Inspection and Testing

Examination of the speed recorder tape removed from the locomotive of No. 21 revealed that prior to arriving at Bloomington, the train was consistently operated at speeds recorded at about the 80-mph level, occasionally reaching as high as 83 mph and as low as 77 mph. The tape also indicated that after leaving Bloomington, the train was consistently operated at speeds of 85 mph or above, twice reaching the 88- to 89-mph level and twice dropping to 80 mph. (See appendix F.)

Following the accident, the speed recorder and speed indicator were calibrated on the basis of an actual wheel diameter of 39.31 inches. It was disclosed that speed was recorded at a rate 2 mph greater than actual speed up to 70 mph; 1 mph greater than actual speed from 80 to 95 mph; and at the correct rate at 100 mph. It was also found that speed was indicated at a rate of 1 to 1 1/2 mph slower than actual speed at virtually all speeds. When the train was traveling at an actual speed of 80 mph, the needle of the speed indicator would be at 79 mph and the speed being recorded on the tape would be 81 mph.

Postaccident sight-distance tests indicated that the fireman should have been able to see clearly and continuously the southbound home signal at Iles from the time No. 21 reached a point 6,060 feet north of that signal and 834 feet north of intermediate block signal 1863 at South Grand Avenue. The engineer should have been able to see the home signal at Iles when it was still 4,760 feet ahead of his train. Due to foliage west of the track and track curvature between Iles and K. C. Junction, the southbound home signal at K. C. Junction was not fully visible to the engineer until his locomotive was 1,676 feet north of the signal. The fireman should have been able to see the home signal when it was over 1,900 feet ahead.

No meaningful postaccident observation of the locomotive controls could be made since it was necessary for rescuers to move the various control handles in the process of releasing the engineer from the operator compartment.

After repairs were made to damaged cables and apparatus, the signal system was restored to service on November 4, 1980. ICG signal supervisors and Federal Railroad Administration signal inspectors inspected and tested the system on that date. All cables,

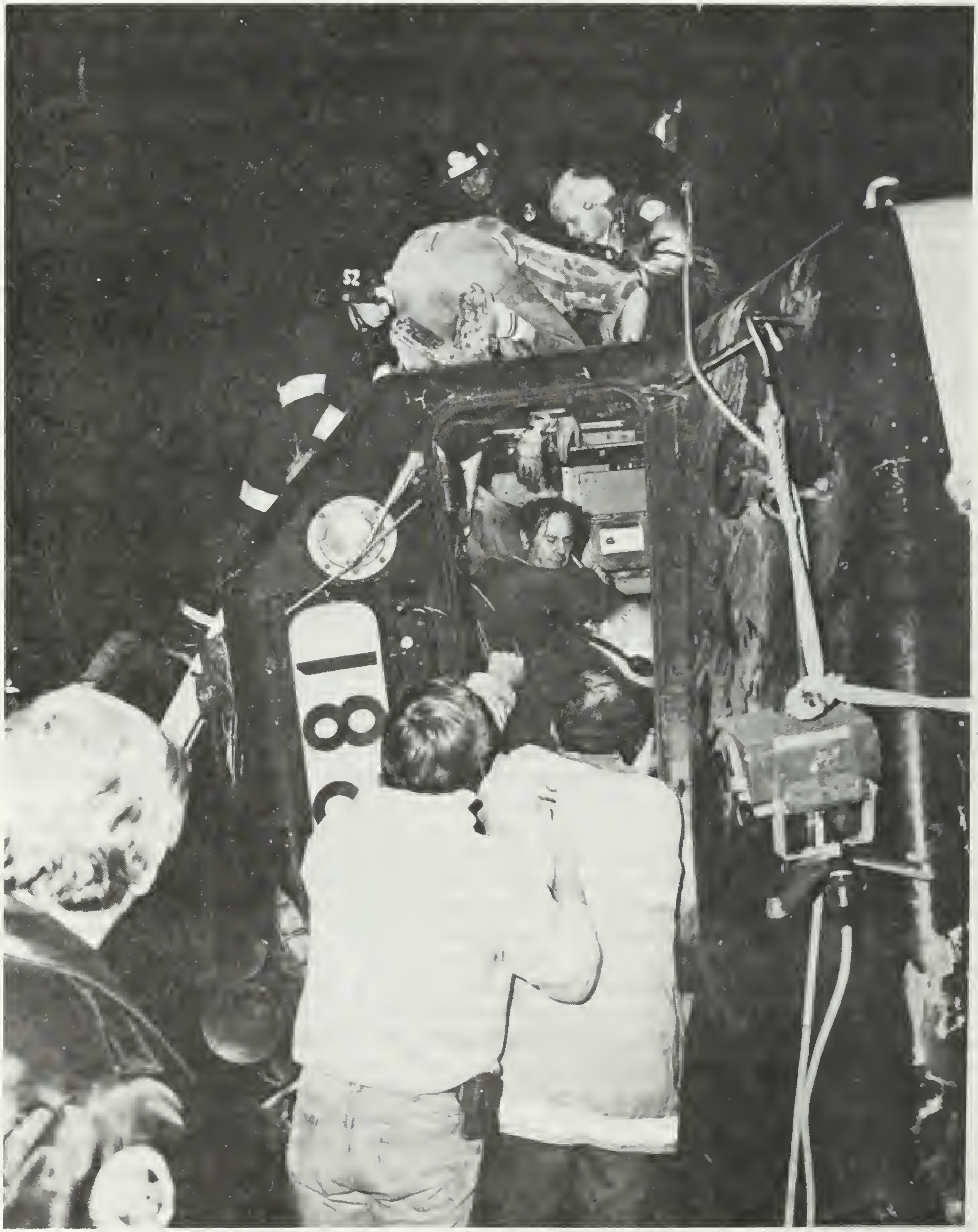

Figure 3.--Emergency personnel removing the engineer from the lead locomotive unit of Amtrak No. 21 about 90 minutes after the train derailed.

Figure 4.—Passengers of Amtrak No. 21 during the evacuation from the derailment area.

relays, and circuitry were found to be free of defect. The combination of signal aspects the fireman and engineer of No. 21 stated they saw displayed at Iles and K. C. Junction could not be duplicated with the left-hand turnout at K. C. Junction aligned to track No. 2, or aligned on the normal, straight route with track No. 1 occupied.

According to Amtrak, the approximate distance required to reduce the speed of a train similar in makeup to Amtrak No. 21 on October 30, 1980, from 60 to 10 mph with a full-service application of the train brakes on level track would be 0.4 mile or 2,100 feet.

Training and Supervision

ICG requires employees in train and engine service to attend instruction and examination classes on the rules, timetable, and other instructions which are conducted by division supervisors every 4 years. The last such classes were conducted in 1978 and ICG plans to conduct classes again during 1982. No special program of training Alton District employees was conducted after color-light type signals were installed at K. C. Junction and Iles during 1975 and 1976. A qualified engineer is considered by ICG to be qualified in both freight and passenger service and no special training or handling is given to an engineer when he moves up to a regular passenger train assignment.

ICG operating supervisors are tested annually on their knowledge of the rules, the timetable, and current bulletin instructions. They are expected to routinely make periodic efficiency checks of train crews during the course of their normal duties. Alton District records indicate that the engineer and fireman who were involved in this accident were subjected to an en-route wayside check by a trainmaster on September 4, 1980. Torpedoes 2/ were placed on the rails, and after the train passed over these, the train was observed to have reduced speed by throttle reduction and train brake application. The trainmaster also noted that the train, Amtrak No. 21, had red markers properly displayed to the rear. On September 9, 1980, the same trainmaster rode with the engineer and fireman from St. Louis to Bloomington on Amtrak No. 22. According to the trainmaster, the enginemen called all signal aspects as required and he evaluated their performance as "very satisfactory."

The investigation found that neither ICG nor Amtrak operating supervisors monitored the locomotive speed recorder tapes of passenger trains to ascertain whether or not the trains were operated in compliance with speed restrictions. There was no record of Amtrak supervisors riding the locomotives of trains No. 21 and No. 22, no record of Amtrak officials taking exception to the track and signal changes made at Iles and K. C. Junction, and no record of en-route checks of Amtrak trains in the Alton District.

ANALYSIS

Operation of Amtrak No. 21

Because the engineer of Amtrak No. 21 wanted to operate the train on schedule, he repeatedly violated the maximum allowable speeds for his train. Although the train departed from Bloomington 4 minutes behind schedule, the engineer was able to make up this time by operating the train between Bloomington and Springfield beyond the maximum authorized 79 mph. However, the need to stop after leaving the Springfield

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2/ Torpedoes are percussion-type charges attached to the tops of rails and which can be easily heard when locomotives pass over and detonate them.

passenger station had again put the train 4 minutes behind schedule. In an effort to make up some of the lost time, the engineer accelerated Amtrak No. 21 at maximum power attaining a speed of 47 mph by the time the train reached the end of a 25-mph restriction at Laurel Street. Since the intermediate block signal at South Grand Avenue had displayed a "clear" aspect, the engineer knew that his train would not be stopped at the N&W crossing at Iles Tower. Because the fireman heard the engineer of Extra 8002 South radio the train order signal aspect at Iles, the Safety Board believes that the engineer of Amtrak No. 21 also heard this radio transmission, understood that the freight train was ahead of his train, and interpreted the "clear" aspect at the South Grand Avenue signal to mean that the freight train had already cleared K. C. Junction. On the basis of their past experience, the enginemen could assume that the dispatcher intended for Amtrak No. 21 to overtake the freight train on the double track between K. C. Junction and Hazel Dell. It probably never occurred to the enginemen that Extra 8002 South would be occupying track No. 1 and that the passenger train was to be routed through the turnout to track No. 2 at K. C. Junction.

The most critical event that preceded the accident was the failure of No. 21's engineer and fireman to observe and comprehend the aspect displayed by the home signal at Iles Tower. This aspect should have indicated to them the route their train was to take at K. C. Junction. Had the signal displayed a green-over-red "clear" aspect to take the straight route, as they supposed, they could pass through K. C. Junction as fast as 79 mph. However, if the signal displayed a yellow-over-green "approach limited" aspect, the train's speed would have to be reduced to 10 mph to permit entering the turnout to track No. 2.

The home signal at Iles should have been visible to the engineer when Amtrak No. 21 was still 4,760 feet north of it. Since the train covered that distance in slightly more than 1 minute, at an average speed of 50 mph, the engineer had to have the ability to promptly recognize and properly interpret the aspect during that time. However, he was apparently totally distracted from that task by, first, the necessity to observe and report to the trainmen the aspect of the relatively dim train order signal located beyond and almost directly in line with the home signal at Iles. Had the train order signal indicated there were train orders for No. 21, the flagman would have to be informed of the fact soon enough to open a vestibule door and get into position to catch the orders as he passed Iles Tower. Since the engineer was probably reluctant to reduce speed for that purpose, the Safety Board believes that he concentrated on the train order signal rather than the home signal. This would be particularly likely in the event the engineer had already assumed that his train was to use the high-speed route through K. C. Junction. No sooner had the engineer recognized and reported the "clear" train order signal, he was confronted by another distraction, the Iles Avenue crossing. Particularly since there was heavy traffic on the street, the engineer's view of the crossing was restricted, and a vehicle may very well have been standing on the crossing. The engineer's attention was probably riveted to the crossing until after he had passed the home signal. The fireman, who was experienced and a promoted engineer, should have observed the signal, but was just as preoccupied with the train order signal and the crossing as was the engineer.

Having most likely failed to perceive and comprehend the signal at Iles, the engineer continued to accelerate Amtrak No. 21, and by the time he was in a position to see the home signal at K. C. Junction, the train was moving at about 60 mph. Had the engineer instantly perceived the aspect as meaning he was routed through the 10-mph turnout and

had immediately made a full-service application of the train brakes, the train probably would have been slowed sufficiently to traverse the turnout safely. However, it is obvious that neither engineman recognized the signal aspect as being different from what they normally received for the straight route and did not realize that their train was routed through the turnout until their locomotive had entered it.

The engineer had reduced ability to see at a distance and was required to wear corrective eyeglasses at all times while on duty. Nevertheless, he put the glasses and train orders in his grip after reading the orders at Bloomington and did not use them again prior to the accident. This may explain why he made an excessive reduction of speed to 50 mph to comply with a 60-mph slow order between Bloomington and Springfield at a time when he was trying to make up lost time, and also explain the discrepancy between his statement concerning the accuracy of the locomotive speed indicator and the results of the postaccident calibration of the indicator. Without his glasses, the engineer probably had more than normal difficulty making out the dim train order signal which contributed to a protracted preoccupation with this signal. Similarly, without his glasses the engineer may have had difficulty distinguishing at a distance the difference between the signal aspect displayed at K. C. Junction and the very similar aspect he was accustomed to seeing at that location.

The investigation revealed that the engineer was not very familiar with timetable speed restrictions, particularly those governing the K. C. Junction turnout which was the most restrictive of any turnout he might have to use on his regular run over the Alton District. Although the color-light signals at Iles and K. C. Junction had been in service for several years, this was the only section on the entire Bloomington-St. Louis trackage used by Amtrak passenger trains where this type of former-IC signal was installed and where three different combinations of aspects indicating separate routes could be displayed. It is evident that the engineer and fireman had never before been confronted by the combination of aspects indicating their route was through the turnout to track No. 2. Since "approach limited" was the most favorable aspect that could be displayed for southbound trains at K. C. Junction and was the aspect habitually displayed there, the enginemen may not have perceived it to be a restrictive aspect when and if they saw it at Iles. Whatever aspect they thought they saw, they did not call it out as required by the rules, and they stated they did not make a practice of calling out nonrestrictive signal aspects. Being former GM&O employees, they had no exposure to the color-light signals prior to 1975 and had received little instruction on these signals since that time. ICG had conducted rules and timetable instruction and examination classes on the Alton District only once since the signals were installed. The employees were expected to learn the signal aspects and signal aspect combinations on their own. But even if they had done this, the knowledge of the relatively complicated color-light signal system the ICG management favored could be readily forgotten if it was seldom needed to be recalled.

Changes in the Track and Signal Systems

The track changes made by ICG between Springfield and Hazel Dell were motivated by the desire to give the former Illinois Central main line a direct connection with the former GM&O Kansas City line. Prior to the advent of the ICG changes, there was a continuous main line for northward trains whereas southbound trains left the double-track section by way of the 30-mph turnout at Hazel Dell. Since the changes resulted in operating difficulties for the Alton District, it appears that little advance and coordinated planning was involved. Apparently, ICG did not make an analysis which would have taken

into account the system's operational efficiency and safety factors. The changes were made piecemeal and were probably based on what was most expedient and least costly at the time. The decision to remove the northbound main track between K. C. Junction and Iles in 1975 eliminated the opportunity to have a continuous main track once Centralized Traffic Control was fully installed. The choice of a No. 10 turnout at the end of the truncated section of double track at K. C. Junction when all other CTC turnouts on the Alton District were the 30-mph No. 20 design was particularly unfortunate. Instead of having two relatively high-speed running tracks 1.7 miles long, ideal for flexible operation under CTC, the dispatchers were given a bottleneck at K. C. Junction which they avoided by running as many trains as possible through the 30-mph turnout at Hazel Dell. As often as possible, meets and runarounds were staged at other locations which had the higher-speed turnouts at both ends. Avoiding the use of track No. 2, particularly as a runaround track, was in itself an unsafe practice because it became commonplace and may have caused train crews to anticipate such action. However, an alert dispatcher might take the option of using track No. 2 as a runaround track for a passenger train if it would probably eliminate a potential delay to that train. Such an occasion was reportedly very rare, but it happened on the night of the accident, and in combination with other factors, set the stage for the derailment of Amtrak No. 21.

When ICG installed the color-light type southbound home signal at K. C. Junction in 1975, and replaced the color-position type home signal at Iles with a color-light type in 1976, it arranged totally different aspect combinations for each of the three routes that a southbound train could take at K. C. Junction. The least restrictive signals were those displayed for the straightline route over track No. 1 and through the turnout at Hazel Dell. The next least restrictive aspects were those displayed for the route through the turnout to track No. 2, and the most restrictive aspects were those displayed for a train routed through the turnout to the Kansas City line. Of the three aspect combinations, the two most similar to each other were those displayed for the Alton District No. 1 track and No. 2 track routes, either of which might be used by 79-mph passenger trains. The most dissimilar set of aspects were those displayed for the 50-mph trains being diverted to the freight-only Kansas City line. Since Iles was the first signal to indicate the routing of southbound trains, it was the more critical of the signals and the use of the most restrictive aspect there would probably have been much more effective in alerting enginemen to the fact that they were routed through the low-speed turnout at K. C. Junction. Particularly in view of the relatively short distance between the signals at Iles and K. C. Junction, the signal engineers who designed the system should have considered the necessity of alerting crews by displaying the most visibly striking aspect it was possible to display at Iles. However, the investigation revealed that the ICG was content that there was adequate stopping distance for passenger trains between the two signals and that engineers could be relied upon to acquaint themselves with the color-light aspects so thoroughly that even if they rarely, if ever, saw an aspect they would instantly recognize it and know what action was required. The wisdom of that reasoning is questionable, at best, in light of what occurred preceding this accident.

Ultimately, ICG retired the northward main track from Iles to Ridgely Yard. Had the southward main track between the same points been retired instead, southbound engineers would have had the ability to see from a greater distance the home signals at Iles and K. C. Junction, the train order signal at Iles, and the Iles Avenue crossing. Realigning Iles Avenue to the south only made the engineers' view of the crossing more restricted than before. Removal of the crossing gates also contributed to the hazardous nature of the Iles Avenue crossing.

The limits of ICG's timetable and speed restrictions should have been identified by milepost references as was done in the case of speed restrictions stipulated in general orders and train orders, rather than by the names of city streets. Considering the Alton District crossed 15 streets between the Springfield passenger station and the end of the 25-mph speed restriction at Laurel Street, it was unreasonable to assume that without speed limit signs or street name signs, engineers would know where the restrictions began and ended.

Permitting passenger trains to operate as fast as 79 mph over the 0.9 mile of trackage between the end of the 25-mph territory at Laurel Street and the 60-mph restriction at Iles Tower was meaningless unless the engineers violated the lesser speed restrictions. Considering the distractions that the engineer of Amtrak No. 21 encountered in this section, it is evident that enforced operation at a considerably lesser speed here and in the short section between Iles and K. C. Junction would be prudent and would not materially affect the running time of the trains.

Although the electronic crew alerter device of the locomotive of Amtrak No. 21 was inoperative, the investigation revealed no indication that the enginemen were other than normal, rested, and fully alert prior to the accident. As a result, the lack of a functioning alerter device was not considered to be a factor in this accident.

Training and Supervision

ICG train and engine service employees are required to attend rules and timetable training classes when they are held every 4 years. This program was not changed on the Alton District even when the color-light type signals were installed at Iles and K. C. Junction. It was not until 3 years after the initial installation of the signals that classes were conducted, and there have been none since. This probably is a fair indication of ICG management's lack of concern for the safety of its operations and assurance that employees have the proper understanding of how they are to function even when radical changes in the operation are made. A further questionable reflection of management attitude is evident in the performance of Alton District supervisors. Although the engineer involved in this accident had a record of noncompliance with speed restrictions and restrictive signal indications (see appendix B), he was evidently allowed to move from freight to regular passenger service without any special instruction or training. Although the ICG medical department had restricted the engineer by requiring him to wear glasses at all times while on duty, he was apparently allowed to reenter service as a passenger engineer before he was notified of that fact. Since no supervisor had followed up to ensure that the engineer had the glasses and was wearing them as required, the engineer was permitted to operate trains without anyone determining whether or not he was complying with the eyeglass requirement.

As a result of his off-the-job training and experience as a volunteer fireman, rather than from any emergency training received as an ICG employee, the conductor of Amtrak No. 21 knew how to take immediate and effective action to provide for the comfort and safety of his passengers after the accident occurred. His highly-skilled handling and evacuation of the passengers, coupled with the emergency lighting equipment of the cars, prevented panic and was probably instrumental in the prevention of injury to the passengers during the evacuation. Actions on the part of the crew of Extra 8002 South, including their ingenuity in illuminating the accident area with their locomotive's headlight also contributed to the successful postaccident operation. The Safety Board

also recognizes and commends the family which assisted in the rescue of the enginemen and opened their home to the passengers and emergency rescue personnel.

Operational Safety On ICG

Since 1969, the Safety Board has investigated 10 major accidents which occurred on Illinois Central Gulf and its predecessor, Illinois Central Railroad. Seven of these accidents involved passenger trains. Additionally, 10 of the 28 Safety Board field investigations of ICG derailments and collisions since 1976 involved passenger trains. Sixty-two persons were killed and 808 persons were injured in the 17 passenger train accidents, a toll far exceeding the experience of any other U. S. railroad system during the existence of the Safety Board. Including those resulting from the investigation of this accident, the Safety Board has made 29 safety recommendations to IC and ICG, far more than have been made to any other railroad.

On September 8, 1970, the crew of an Illinois Central Yard train failed to comply with a restrictive signal indication and their train collided with the train of another railroad at Riverdale, Illinois. 3/ The Safety Board's investigation developed that track changes led to modification of the critical signal so that it continuously displayed a red "stop-and-proceed" aspect which, in turn, resulted in train crews habitually disregarding the signal's aspect. Further, a few days before the accident, IC modified its rule covering the aspect so that it was no longer necessary for trains to stop before passing the signal. The Safety Board concluded that the accident would not have occurred had the IC crew complied with the rules. However, the Board's probable cause also included IC's failure to provide positive protection after making the track and signal changes, and "inadequacies in IC's operating rules, practices, and personnel training." As a result, the Safety Board recommended that IC "take the necessary action to ensure that its employees comply with the Company's operating rules." The recommendation was subsequently reiterated in the Safety Board's special study on train accidents attributable to employee negligence. 4/

The collision of two ICG commuter trains at Chicago in October 1972 killed 45 persons and injured 332. 5/ The Safety Board concluded that the same inadequacies in ICG's operating rules, practices, and personnel training which had contributed to the Riverdale accident were also factors in the Chicago accident. Further, the Board stated that ICG's supervisors had accepted the inadequacies and suggested that management had failed to respond to the situation. As a result of its investigation, the Safety Board recommended that ICG "ensure that its employees understand and comply with its rules; ....improve its training program by developing: a system of regularly testing the ability of employees to interpret actions required in specific operating situations;" and "....review its organizations systematically to ensure that safety is covered adequately in all interactions of equipment, personnel, rules, and procedures."

3/ Railroad Accident Report--"Illinois Central Railroad Company and Indiana Harbor Belt Railroad Company, Collision Between Yard Trains at Riverdale, Illinois, September 8, 1970" (NTSB-RAR-71-3).
4/ Special Study--"Train Accidents Attributed to the 'Negligence of Employees'" (NTSB-RSS-72-1).
5/ Railroad Accident Report--"Collision of Illinois Central Gulf Railroad Commuter Trains, Chicago, Illinois, October 30, 1972" (NTSB-RAR-73-5).

On October 12, 1979, a switchtender at ICG's Harvey, Illinois yard threw a main track switch in front of a moving Amtrak passenger train causing the train to enter a track occupied by a standing freight train. 6/ Two crewmembers on the freight train were killed and 44 persons were injured. The investigation revealed that the switch involved in the accident had no interlock or other positive means to prevent its movement, and that the switchtender had not been adequately trained or supervised in his duties. Further, it was learned that this and other main track switches at Harvey had formerly been equipped with electric lock devices. Apparently to expedite operations, ICG had removed the electric locks but had not substituted any positive means to protect against the accidental misalignment of the switches. Among the recommendations the Safety Board made to ICG as a result of the investigation of this accident was yet another call for improved employee training and supervision.

During the decade between the Riverdale and Springfield accidents, ICG responded positively to a number of Safety Board recommendations. However, basic inadequacies in rules, practices, and personnel training, repeatedly cited by the Board, have seemingly continued to persist. Engineering changes have continued to cause operating situations that ultimately are at least factors in serious accidents. The record suggest that there has not been the fundamental change in ICG policy necessary to produce meaningful and long-lasting improvement in operational safety. Neither the 1972 catastrophe at Chicago nor the 1973 Safety Board recommendation that safety be factored into all operational aspects seem to have resulted in any demonstrable change in the situation.

Amtrak Concern For Safety

On June 10, 1971, Amtrak passenger train No. 1 derailed on the Illinois Central near Salem, Illinois. 7/ Eleven passengers were killed and 163 persons were injured in this, the first major Amtrak accident. There have been a number of derailments and collisions involving Amtrak trains on ICG since this accident including five that occurred during the 13 months preceding the Springfield accident. All but one of these, as was the case with the Springfield derailment, occurred within a 200-mile radius of Chicago.

Amtrak was justifiably concerned with "on time" performance, but should have been even more concerned with the safety of its trains and its passengers. Although ICG operated its trains, Amtrak could have remedied the situation since it always had the option to operate its trains over other railroads between Chicago and St. Louis. Since it elected to use ICG, Amtrak, having operating supervisors, safety supervisors, route engineers, and other officials headquartered at Chicago and St. Louis, should have monitored ICG's management of their trains, particularly after the Harvey accident in 1979. They could have regularly made on-board and lineside checks and should have routinely monitored the speed recorder tapes removed from their locomotives. Route engineers should have been concerned with the track and signal changes at Iles-K.C. Junction. Yet, there is no record that any of these were done or that Amtrak had taken exception to the operation of trains across the Alton District.

6/ Railroad Accident Report—"Head-End Collision of Amtrak Train No. 392 and ICG train No. 51, Harvey, Illinois, October 12, 1979" (NTSB-RAR-80-3).

7/ Railroad Accident Report--"Derailment of Amtrak Train No. 1 on the Illinois Central Railroad near Salem, Illinois, June 10, 1971 "(NTSB-RAR-72-5).

CONCLUSIONS

Findings

1. Because the engineer of Amtrak No. 21 wanted to operate the train on schedule, he repeatedly violated timetable restrictions.

2. When Amtrak No. 21 left Springfield on a "clear" aspect displayed by the signal at South Grand Avenue, the engineer and fireman knew their train would not be stopped at Iles and that Extra 8002 South had already cleared K. C. Junction. On the basis of routine dispatching practice and their own experience, they assumed their train was to be routed through K. C. Junction to track No. 1 and that they could operate as fast as the 79-mph speed permitted at that location.

3. The dispatcher decided to have Amtrak No. 21 overtake Extra 8002 South by way of track No. 2 between K. C. Junction and Hazel Dell. This was contrary to routine practice; however, the decision was made at a time when it appeared that to do otherwise would delay Amtrak No. 21.

4. The southbound signals at Iles and K. C. Junction displayed the proper aspects for the route the dispatcher had coded the Centralized Traffic Control machine to align for Amtrak No. 21.

5. The need to quickly determine and report to the trainmen the aspect of the train order signal at Iles Tower, and the hazardous nature of the Iles Avenue crossing distracted the engineer and fireman of Amtrak No. 21 so that they failed to perceive and comprehend the home signal at Iles. The time they had to observe both signals was significantly reduced by the engineer's operation of the train at excessive speed leaving Springfield.

6. The engineer's failure to wear his corrective eyeglasses as required contributed to his preoccupation with the train order signal and to his failure to perceive and comprehend the home signal aspects displayed at Iles and K. C. Junction.

7. The engineer and fireman may have never before encountered an "approach limited" aspect at Iles. Because it was relatively similar to the "clear" aspect they habitually saw there and since "approach limited" was also the aspect displayed at K.C. Junction for the straight route, they probably did not comprehend its restrictive nature when it was displayed at Iles.

8. Amtrak No. 21 was traveling at 63 mph with the locomotive in full power when it entered the 10-mph turnout at K.C. Junction. No braking action had been initiated.

9. The derailment occurred because the speed of Amtrak No. 21 exceeded the design capability of the turnout.

10. The installation of a No. 10, 10-mph turnout, where two main tracks diverged in a territory where all passing track turnouts were of the No. 20, 30-mph design, led to the routine practice of using the No. 10 turnout as seldom as possible.

11. The former GM&O engineer and fireman were accustomed to the color-position type signals used on the Alton District and because they seldom, if ever, saw most of the color-light signal aspects which could be displayed at Iles and K. C. Junction, they probably did not comprehend what action those aspects required.

12. The piecemeal track changes that ICG made between Springfield and K. C. Junction were based on what was most expedient and least costly rather than on what could be done to improve operational efficiency and safety.

13. Using the 30-mph turnout at Hazel Dell to avoid using track No. 2 as a runaround track was so commonplace that the practice may have been normally anticipated by the enginemen of No. 21 as well as by the other passenger train crews on the Alton District.

14. When ICG installed the color-light signals at Iles and K. C. Junction, relatively similar combinations of aspects were used to indicate which of the two Alton District routes were to be used at K.C. Junction, although there was an extraordinary difference in the permissible speeds for the two routes.

15. Installation of color-light type signals at Iles and K. C. Junction on a main line otherwise equipped with the radically different color-position type signals was questionable engineering judgment which adversely affected the safety of the Alton District operation. The fact that it was permitted by ICG is indicative of a lack of concern for operational safety.

16. Removal of the gates and realignment of the street tended to increase the hazardous nature of the Iles Avenue crossing and contributed to the potential distraction of southbound ICG engineers who needed to be concentrating on the signal aspects displayed at that location.

17. The lack of proper reference points for 15- and 25-mph speed restrictions at Springfield and the practice of allowing passenger trains to travel as fast as 79 mph for less than 1 mile beyond the 25-mph restriction would tend to encourage schedule-conscious engineers to violate the 25-mph restriction and to reduce the time they had to comprehend the signals at Iles.

18. ICG made little effort to assure that the color-position oriented Alton District employees understood what the new color-light signal aspects indicated.

19. Repeated changes in the names of the interlockings as well as confusing bulletin instructions covering the signal and track changes were indicative of a lack of advance planning on the part of ICG.

20. Particularly, in view of his record of violating signal rules and speed restrictions, the engineer of Amtrak No. 21 should not have been allowed to operate passenger trains without receiving additional training from ICG operating and safety officers. Once permitted to operate passenger trains, the engineer's performance should have been closely monitored by Alton District supervisors.

21. After the engineer was required to wear corrective eyeglasses at all times while on duty, Alton District supervisors should have ascertained that he had the proper glasses and that he clearly understood what was required by the restriction.

22. Although ICG examines its train service employees on the operating rules and timetable instructions, doing this on a quadrennial basis is inadequate to insure that employees remain conversant with what is required, especially when highly radical changes are made in the methods of operation.

23. Although an Amtrak train was involved in a collision on the ICG in October 1979 and the investigation of the accident revealed serious operational deficiencies, Amtrak officials in the Chicago-St. Louis territory had not undertaken any program of observations and checks of the operation of Amtrak trains on the ICG, including basic and routine surveillance, such as the monitoring of locomotive speed tapes.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the operation of Amtrak No. 21 into the No. 10 turnout at a speed significantly higher than the turnout's design speed, due to the failure of the train's engineer and fireman to perceive and comprehend that the color-light signal aspects displayed for their train indicated that it was to be routed through the 10-mph (No. 10) turnout. This failure resulted from the routine dispatching of passenger trains to avoid the turnout, the crew's lack of familiarity with the color-light type signal aspects, distraction of the enginemen, and the train speed exceeding the 25-mph restriction between the Springfield passenger station and Iles Tower. Contributing to the accident were ICG's poorly planned modifications to the signal and track systems at Iles and K.C. Junction, ICG's inadequate instruction of Alton District employees on the color-light signals, ICG's and Amtrak's failure to adequately monitor the performance of Alton District employees in passenger service, and the failure of the engineer of Amtrak No. 21 to wear eyeglasses as required.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

—to the Illinois Central Gulf Railroad:

> Take immediate action to determine that train and engine service employees of the Alton District are fully conversant with and comply with timetable speed restrictions and the various color-light signal aspects that can be displayed at Iles and K.C. Junction. (Class II, Priority Action) (R-81-61)
>
> Increase the frequency with which train and engine service employees are instructed and examined on the rules, timetable, and bulletin instructions. (Class II, Priority Action) (R-81-62)

Erect speed limit signs as provided for in its rules, and/or provide milepost references in its timetable to indicate the limits of restricted speed sections on the Alton District at Springfield, Illinois. (Class II, Priority Action) (R-81-63)

Reduce the allowable speed for passenger trains between Laurel Street and K.C. Junction to a speed that is consistent with the restrictions north of Laurel Street and at the N&W crossing as well as the possibility that a train may have to reduce speed to 10 mph at K.C. Junction. (Class II, Priority Action) (R-81-64)

In cooperation with the National Railroad Passenger Corporation (Amtrak), develop and execute a program of surveillance of passenger train operations on the Alton District, including on-board determination of how engine crews comply with signal aspects, speed restrictions, and ICG Rule 34, as well as routine monitoring of locomotive speed recorder tapes. (Class II, Priority Action) (R-81-65)

Require that appropriate division officers determine that enginemen who have been restricted because of impaired vision have obtained proper corrective eyeglasses and fully understand the nature of their restriction before they are allowed to continue in service. (Class II, Priority Action) (R-81-66)

—to the National Railroad Passenger Corporation (Amtrak):

In cooperation with the Illinois Central Gulf Railroad, develop a program of close surveillance of the operation of its trains on ICG's Alton District which includes the compliance of train crews with speed restrictions and signal aspects, as well as the monitoring of locomotive speed recorder tapes. (Class II, Priority Action) (R-81-67)

Make route and schedule studies to determine that Amtrak trains can be safely operated over the ICG's Alton District on the existing schedules. (Class II, Priority Action) (R-81-68)

—to the Federal Railroad Administration (FRA):

Conduct a safety review of the Alton District of the Illinois Central Gulf Railroad to determine whether existing track and signal features, existing training of employees, and the enforcement of the operating rules and timetable are adequate for the safe operation of passenger trains over this district. (Class II, Priority Action) (R-81-69)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

April 28, 1981

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of the accident about 10:45 p.m., on October 30, 1980. The Safety Board immediately dispatched an investigator from the Chicago Field Office to Springfield and subsequently dispatched an investigative team from Washington, D.C. to the scene. Investigative groups were established for operations, vehicle factors, track and signals, and human factors.

Depositions

The Safety Board conducted a 1-day deposition proceeding on January 15, 1981, at Springfield, Illinois, as part of its investigation of this accident. Parties to this proceeding included the Illinois Central Gulf Railroad, the National Railroad Passenger Corporation (Amtrak,) the Illinois Commerce Commission, the Brotherhood of Locomotive Engineers, and the United Transportation Union. Testimony was taken from seven witnesses.

APPENDIX B

TRAIN CREWMEMBER INFORMATION

Amtrak No. 21

Conductor Donald E. Schenkel

Donald E. Schenkel, 41, was employed as a brakeman by the Gulf, Mobile and Ohio Railroad on May 15, 1960, and was promoted to conductor on May 15, 1966. He passed a company physical examination on October 26, 1979, and he was last examined on the ICG operating rules on November 22, 1978. He was not restricted in any way. He had been regularly assigned as a passenger conductor since December 1979. On April 21, 1980, he was issued a letter of caution as a result of his violation of ICG rule 93 on ICG's Joliet District, between Chicago and Bloomington. According to the letter, a radar speed check indicated his passenger train was running at 47 mph at a location where yard speed (a speed not exceeding 20 mph) applied.

Engineer Morris G. Colson

Morris G. Colson, 53, was employed as a brakeman by the Gulf, Mobile and Ohio Railroad on February 3, 1956, was transferred to engine service on January 18, 1957, and was promoted to engineer on August 1, 1962.

During July 1980, he experienced a mild heart attack and subsequently was under convalescence for about 6 weeks. On the basis of an examination by his personal physician and a company doctor on August 26, 1980, he was found to be physically fit for duty. However, the company doctor's report indicated that he needed glasses for distance vision, and that once he had the corrective eyeglasses he could return to work as an engineer. Mr. Colson received the glasses and returned to duty, as the engineer of Amtrak No. 21 on August 29, 1980. On September 8, 1980, ICG's Chief Medical Officer notified the St. Louis-Missouri Division superintendent in writing that Mr. Colson "must wear glasses at all times while on duty." The trainmaster at Bloomington forwarded a copy of the notification to Mr. Colson on September 9. There is no known record of Mr. Colson having actually received the notice or of being notified verbally of the restriction by an Alton District supervisor. Following the accident, he stated he had never been told he had to wear the glasses at all times while on duty.

Mr. Colson was last examined on the operating rules on June 28, 1978. His service record indicates that he was disciplined for passing a "stop" aspect on a home signal in December 1960; reprimanded for failure to stop short of a "stop" aspect on a home signal in September 1974, operating a train at excessive speed in violation of signal rules on April 16, 1975, and for "failure to stop your engines when two switches were lined against you," on April 29, 1975; suspended for 5 days for failure to stop his engine short of another train on May 29, 1975; reprimanded for running at excessive speed on September 17, 1975; and suspended for 30 days for running past a "stop" aspect at an interlocking that resulted in a derailment on May 26, 1978.

Fireman James E. Byrd

James E. Byrd, 40, was employed as a brakeman by the Gulf, Mobile and Ohio Railroad on July 10, 1968, transferred to engine service on September 2, 1969, and

promoted to engineer on October 17, 1973. He last passed a company physical on October 17, 1978, and was last examined on the operating rules on May 11, 1978. He was not restricted in any way. He had been regularly assigned in passenger service for about 3 years prior to the accident. His service record was clear of reprimand or disciplinary action.

Flagman James R. Price

Flagman Price, 45, was employed as a brakeman by the Gulf, Mobile and Ohio Railroad on June 23, 1957. He was promoted to conductor on August 31, 1963. He last passed a company physical examination on April 30, 1979, and was last examined on the operating rules on June 9, 1978. He was not restricted in any way. He was suspended for 60 days on April 14, 1978, for a violation of operating rules in connection with the failure to properly execute a meet between two passenger trains on the Alton District.

APPENDIX C

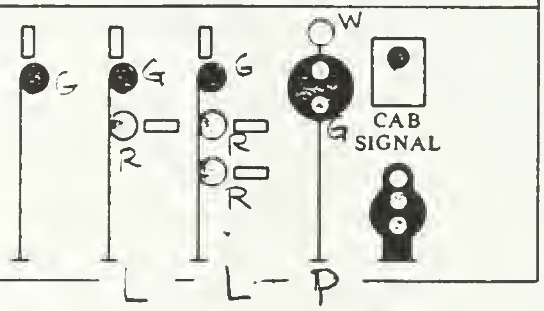
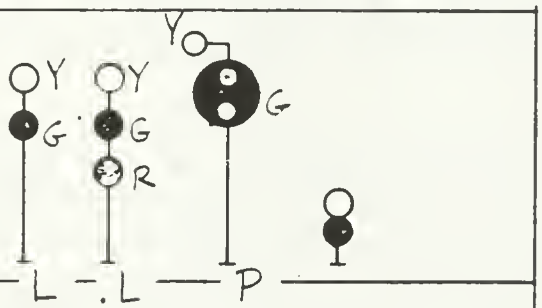
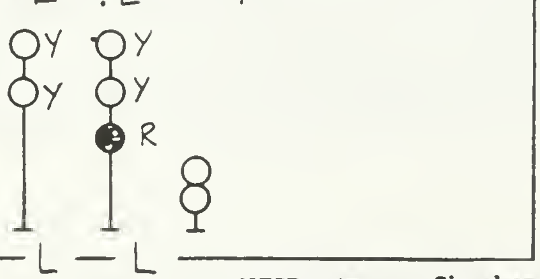
EXCERPTS FROM ILLINOIS CENTRAL GULF OPERATING RULES

34. Employes located in the operating compartment of an engine must, and other crew members will, when practical, communicate to each other in an audible and clear manner the name or aspect of each signal affecting movement of their train or engine, as soon as the signal is clearly visible or audible. It is the responsiblity of the engineer to have each employe in cab of engine comply with these requirements, including himself.

Each fixed signal must be watched until such signal is passed and if it displays an indication other than that first communicated, the change must be communicated as soon as it becomes clearly visible.

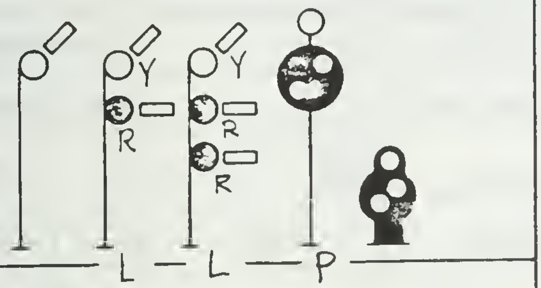
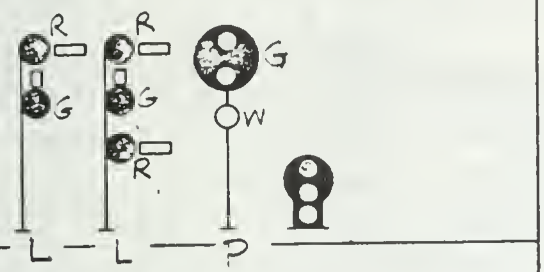
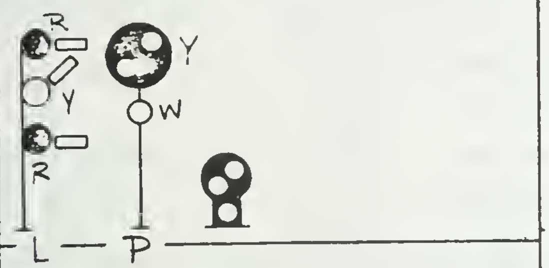
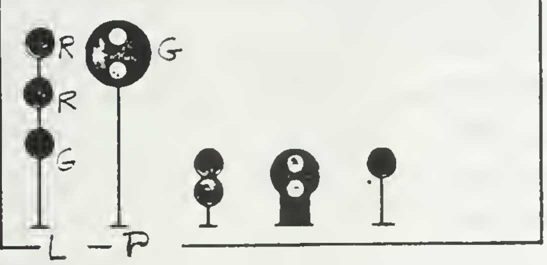
It is the engineer's responsiblity to have each employe located in the operating compartment maintain a constant lookout for signals and conditions along the track which affect the movement of the engine or train.

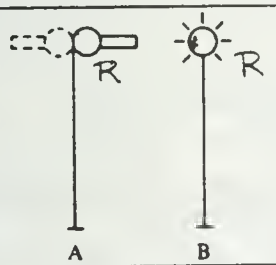
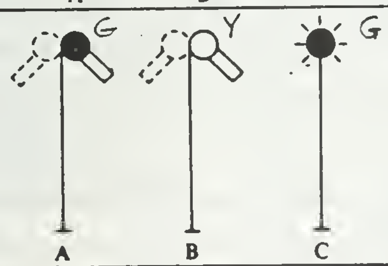
If a crew member becomes aware that the engineer has become incapacitated or should the engineer fail to operate or control the engine or train in accordance with signal indications or other conditions requiring speed to be reduced, other members of the crew must communicate with the engineer at once, and if he fails to properly control the speed of the train or engine, other members of the crew must take action necessary to ensure the safety of the train or engine, including operating the emergency brake valve. (Revised January 1, 1978)

RULE	Block and Interlocking Aspects	NAME	INDICATION
281		Clear	Proceed.
283		Approach Limited	Proceed; approaching next signal prepared to enter turn out at prescribed speed, but not exceeding 40 MPH.
284		Medium Approach	Proceed; approaching next signal prepared to enter turn out at prescribed speed, but not exceeding 30 MPH.

NTSB note: Signal aspects designated "L" are color-light type; aspects designated "P" are color-position type. "R" indicates red; "G" indicates green; "Y" indicates yellow; "W" indicates white lights.

APPENDIX C

RULE	Block and Interlocking Aspects	NAME	INDICATION
285		Approach	Proceed; prepared to stop at next signal. Train exceeding 30 MPH must at once reduce to that speed.
286		Diverging Clear	Proceed on diverging route; not exceeding prescribed speed through turn out.
287		Diverging Approach	Proceed on diverging route; through turn out at prescribed speed; prepared to stop at next signal, but not exceeding 30 MPH.
288		Slow Clear	Proceed; at prescribed speed within interlocking limits, or through turn out.

RULE	Train Order Signal Aspects	NAME	INDICATION
297		Stop	Stop; unless clearance received, or as provided in Rule 221 (g).
298		Clear	Proceed.

<u>NTSB note:</u> **Signal aspects designated "L" are color-light type; aspects designated "P" are color-position type. "R" indicates red; "G" indicates green; "Y" indicates yellow; "W" indicates white lights.**

APPENDIX D

EXCERPTS FROM ICG ST. LOUIS–MISSOURI DIVISION TIMETABLE NO. 4

Southward						ALTON DISTRICT				Northward
FIRST CLASS			Siding Length In Feet	Siding, Standing Room, Cars With Engine.	Mile Posts	TIMETABLE NO. 4	Miles From St. Louis	FIRST CLASS		
21	303	301				Effective August 3, 1980		300	22	304
INTER-AMERICAN	STATEHOUSE	ANN RUTLEDGE				STATIONS		STATEHOUSE	INTER-AMERICAN	ANN RUTLEDGE
Daily	Daily	Daily								
Ls 7 30PM	Ls 4 35PM	Ls10 21AM			126.6	C. BLOOMINGTON	155.5	As 7 40AM	As11 37AM	As 6 52PM
			12,430	226	140.9	14.3 McLEAN	141.2			
			4,235	77	145.8	4.9 ATLANTA	136.3			
s 7 57	s 5 04	s 10 50	10,010	182	156.4	10.6 LINCOLN	125.7	s 7 10	s 11 05	s 6 20
					163.4	7.0 BROADWELL	118.7			
			9,625	175	167.3	3.9 ELKHART	114.8			
8 15	5 25	11 11			177.6	10.3 SHERMAN	104.5			
			10,175	185	182.9	5.3 C. RIDGELY	99.2	6 45	10 40	5 55
s 8 30	s 5 40	s 11 26			185.1	2.2 SPRINGFIELD	97.0	s 6 40	s 10 35	s 5 50
8 35	5 45	11 31			187.3	2.2 C. ILES	94.8	6 30	10 37	5 42
					187.8	0.5 K. C. JCT.	94.3			
					189.5	1.7 HAZEL DELL	92.6			
			10,505	191	200.6	11.1 AUBURN	81.5			
			5,830	106	207.0	6.4 VIRDEN	75.1			
			9,625	175	210.8	3.8 GIRARD	71.3			
					214.5	3.7 NILWOOD	67.6			
s 9 07	6 15	12 01PM	17,490	318	223.8	9.3 CARLINVILLE	58.3	s 6 00	9 58	5 13
			11,165	203	238.3	14.5 SHIPMAN	43.8			
					246.0	7.7 BRIGHTON	36.1			
9 31	6 37	12 23	13,420	244	252.1	6.1 GODFREY	30.0	5 35	9 35	4 50
s 9 39	s 6 45	s 12 31			257.2	5.1 ALTON	24.9	s 5 30	s 9 30	s 4 45
A 9 43PM	A 6 49PM	A 12 35PM			262.1	2.9 C. WANN	22.0	L 5 25AM	L 9 25AM	L 4 40PM
						BE GOVERNED BY JOINT CONRAIL—ICG TIMETABLE		Daily	Daily	Daily
					274.9	12.8 C. GRANITE CITY	9.2			
					278.0	3.1 VENICE JCT.	6.1			
					280.0	2.0 BRIDGE JCT.	4.1			
						TRRA ROUTE				
L 9 59PM	L 7 05PM	L 12 51PM			274.9	12.8 C. GRANITE CITY	9.2	L 5 10AM	L 9 10AM	L 4 25PM
A 10 45PM	A 7 50PM	A 1 35PM			284.1	9.2 ST. LOUIS A.S.	0.0	L 4 45AM	L 8 45AM	L 4 00PM

14 SPECIAL INSTRUCTIONS (continued from page 13)

101. SPEED RESTRICTIONS: SPEEDS SHOWN ARE MAXIMUM AUTHORIZED BETWEEN POINTS NAMED

Territory or Location	Passenger Trains	TOFC Trains	Freight Trains
	MILES PER HOUR		
Between:			
NORMAL DISTRICT			
South Joliet and Bloomington	79	60	50
PEQUOT DISTRICT			
South Joliet and Mazonia	79	60	50
PONTIAC DISTRICT			
Pontiac and Flanagan		20	20
BLOOMINGTON DISTRICT			
Normal Jct. and Barnes, MP 135			10
JACKSONVILLE DISTRICT			
Bloomington and Murrayville			25
ALTON DISTRICT			
Bloomington and Ridgely	79	60	50
Ridgely and Wann	79	50	50

16 SPECIAL INSTRUCTIONS (continued from page 15)

101(a). LOWER SPEEDS. (Continued)

Territory or Location	Passenger Trains	Freight Trains Including TOFC
	MILES PER HOUR	
ALTON DISTRICT		
Lincoln: Between railroad crossings, Athol to South Lincoln	70	50
MP 181 to Ridgely Interlocking (See Note C)		
Ridgely Interlocking:		
North Crossover	10	10
South Crossover	10	10
Ridgely Interlocking to Ridgely Ave., both tracks	35	25
Springfield: Ridgely Ave. to Carpenter St.	25	25
Carpenter St. to Capital Ave.	15	10
Capital Ave. to Laurel St.	25	25
Iles: N&W Crossing	60	50
K.C. Jct: All Turnouts	10	10
Mile 226.8, Rinaker, to Mile 234.2, Plainview	70	40
Mile 227.6 to MP 229 (See Note C)		
MP 233: First curve North and second curve South (See Note C)		
Godfrey: Curve, Mile 252.3 (Also See Note C)	60	40
Turnouts to Carrollton District	10	10
Mile 252.3 to College Avenue	70	40
Mile 258.3, Wood River Creek	25	25
Cars with swivel couplers, when loaded, are restricted as follows:		
Ridgely to Iles		10
MP 254 to Pearl St., Godfrey		10
Granite City to Venice		10

APPENDIX E

ILLINOIS CENTRAL GULF RAILROAD
ORDERS FROM OFFICE OF SUPERINTENDENT

Bloomington, Illinois
April 14, 1975

MISSOURI DIVISION (Alton & Air Line Districts)

BULLETIN ORDER NO. 32-75

ALL CONCERNED:

Rules: 277, 277(a), 278, 281, 283, 284, 285, 286, 287, 288, 290, 291, 292 and 525 to 542.

Effective 4:01 P.M., Thursday, April 17, 1975 the following track and signal changes are made at Springfield, Illinois.

AT N&W CROSSING INTERLOCKING

Air line district switch is removed from the interlocking.

AT ILES

Kansas City connection power switch is placed in service, and is equipped with dual control switch machine. Hand operation of this switch is in accordance with Rules 277, 277(a) and 278.

Home signals governing movements over the power switch display aspects as follows:

ASPECT	RULE	ROUTE
SOUTHWARD		
Yellow over Red over Red	285	To Track 1
Yellow over Green over Red	283	To Track 1
Red over Green over Red	286	To Track 2
Red over Yellow over Red	287	To Track 2
Red over Red over Green	288	To Kansas City
Red over Red over Red	292	STOP
NORTHWARD - FROM KANSAS CITY		
Red over Red over Yellow	290	To N&W Crossing
Red over Red over Red	292	STOP

NTSB note: Facsimile of the bulletin covering the original changes at Iles and K. C. Junction. At this time, Iles had been renamed N&W Crossing Interlocking and what later became K. C. Junction was designated as Iles. No bulletin was issued to cover the subsequent re-designation of these locations.

Bloomington, Illinois
February 2, 1976

MISSOURI DIVISION (Alton & Air Line Districts)

BULLETIN ORDER NO. 17

ALL CONCERNED:

RULES: 281, 283, 284, 286, 287, 290 and 292.

Effective at time and date to be specified by Train Order, the following signal changes are made at Springfield, Illinois:

AT N&W CROSSING INTERLOCKING

Northward dwarf home signal is replaced with high home signal, and displays aspects as follows:

ASPECT	RULE	ROUTE
White Marker over Green	281	To Southward Main Track
Green over White Marker	286	To Northward Main Track
Yellow over White Marker	287	To Northward Main Track
Red	292	STOP

Southward color position light home signal is replaced with color light signal and displays aspects in accordance with Rules 281, 283, 284, 290 and 292.

SIGNED: A. H. BURTON, SUPERINTENDENT

POSTED __________ AM/PM ______________________ 1976 BY ______________________

NTSB note: Facsimile of the bulletin covering the original changes at Iles and K. C. Junction. At this time, Iles had been renamed N&W Crossing Interlocking and what later became K. C. Junction was designated as Iles. No bulletin was issued to cover the subsequent re-designation of these locations.

GENERAL ORDER NO 583

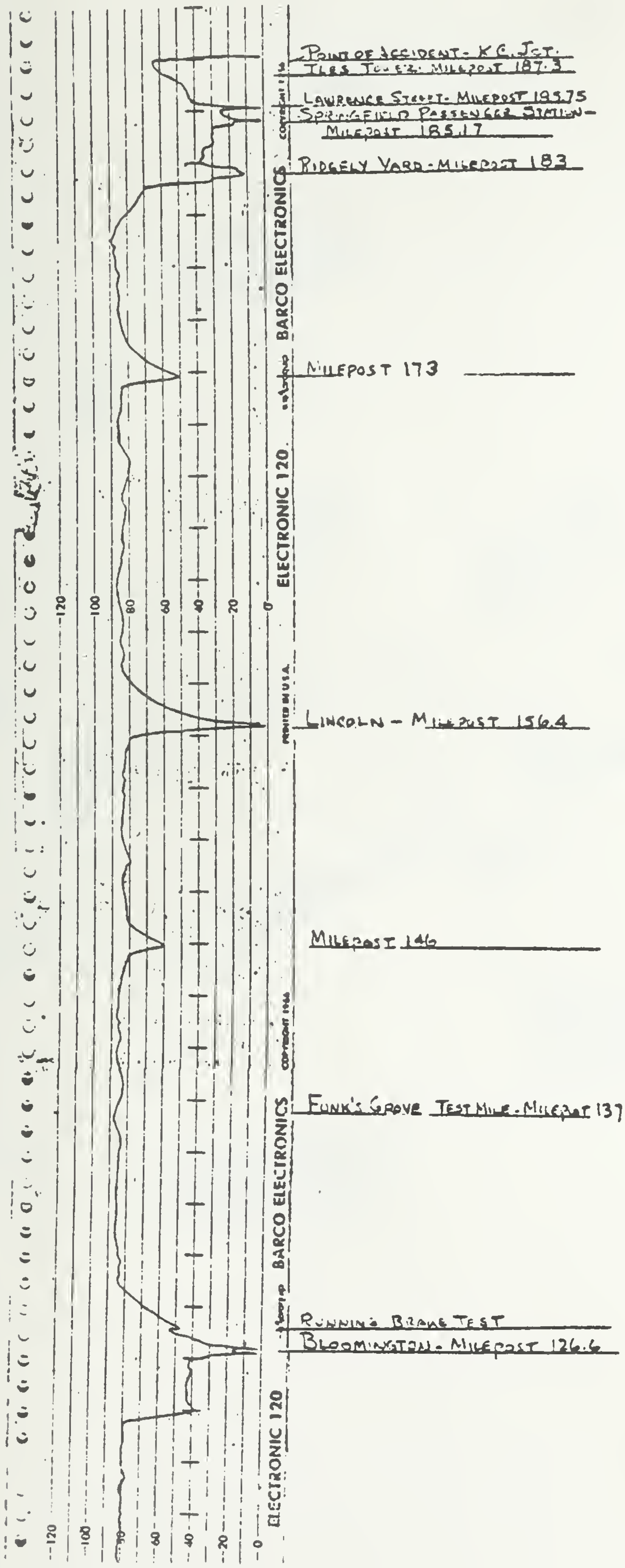
EFFECTIVE 1201 AM THURSDAY OCT 30TH, 1980 GENERAL ORDER NO 579 IS CANCELLED AND THE FOLLOWING REDUCE SPEED AND OTHER RESTRICTIVE CONDITIONS WILL BE IN EFFECT ON THE ALTON DISTRICT.

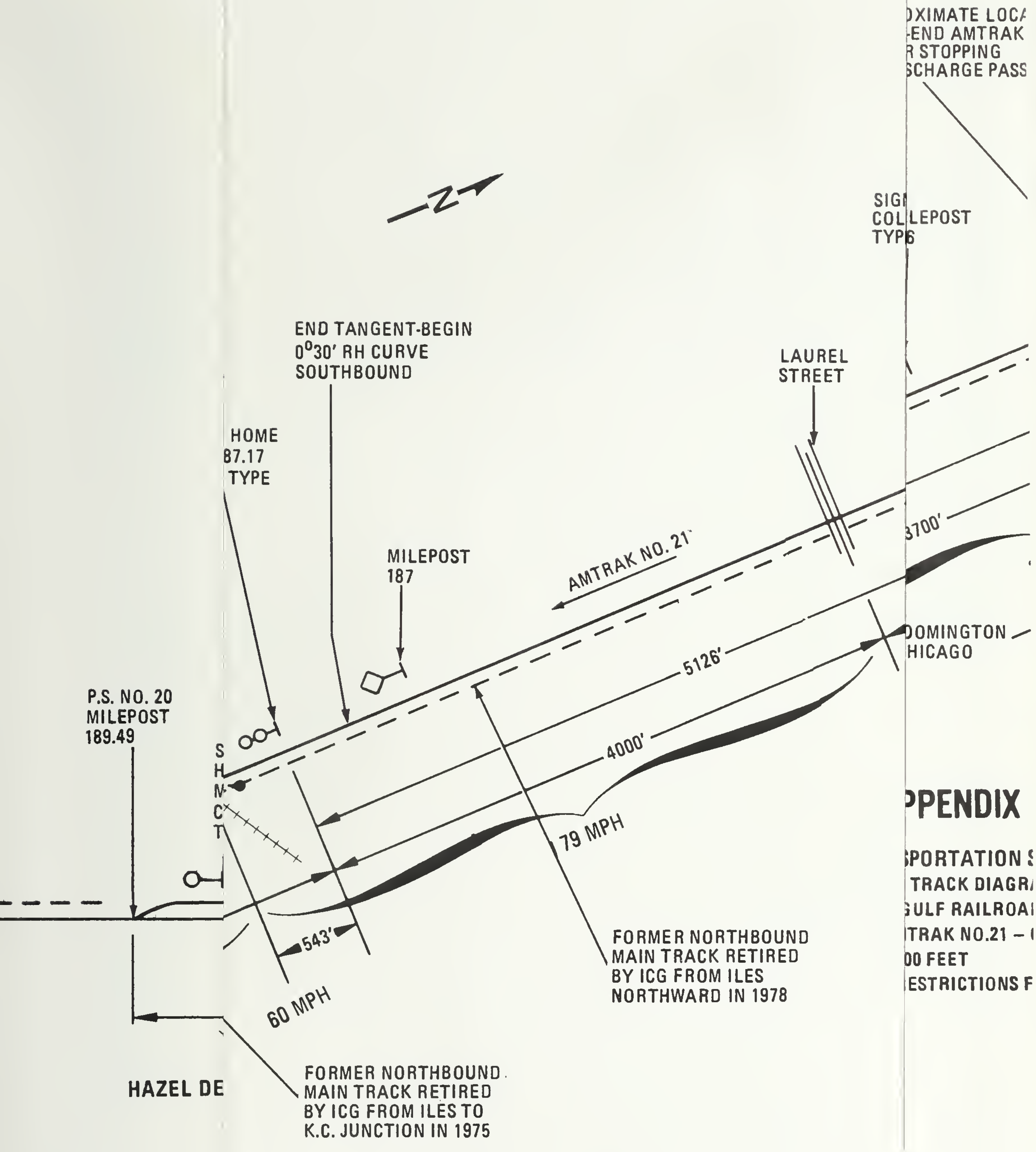
ITEM	PSGR SPEED	FRT SPEED	LOCATION
1	60	40	BETWEEN MILE 145.7 AND MP 146 ON CURVE ATLANTA. YELLOW SIGNS ARE DISPLAYED.
2	60	40	BETWEEN MILE 172.8 AND MP 173 WILLIAMSVILLE. YELLOW SIGNS ARE NOT DISPLAYED.
3	15	10	THROUGH C.T.C. SIDINGS AUBURN AND CARLINVILLE.
4	50	30	OVER ROAD CROSSING AT MILE 208.5 BETWEEN VIRDEN AND GIRARD. YELLOW SIGNS ARE NOT DISPLAYED
5	40	25	BETWEEN MP 222 AND MP 223 NORTH OF CARLINVILLE YELLOW SIGNS ARE NOT DISPLAYED.

J.E.MOSS
SUPT OF TRANSPORTATION
ISSUED OCT 27TH, 1980
SHEET ONE OF ONE

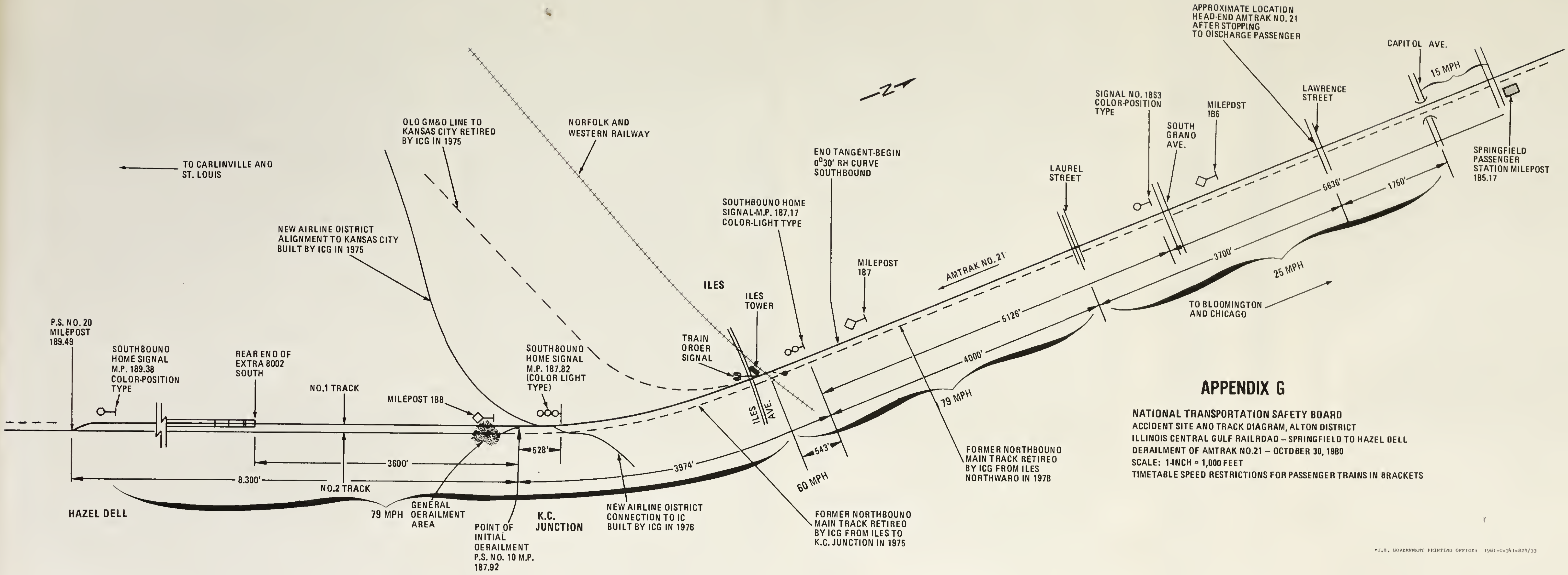
APPENDIX F

LOCOMOTIVE SPEED RECORDER TAPE REMOVED FROM AMTRAK NO. 21





OXIMATE LOCA
-END AMTRAK
R STOPPING
SCHARGE PASS
SIG
COL LEPOST
TYP 6
END TANGENT-BEGIN
0°30′ RH CURVE
SOUTHBOUND
LAUREL
STREET
HOME
87.17
TYPE
MILEPOST
187
AMTRAK NO. 21
3700′
OOMINGTON
HICAGO
5126′
P.S. NO. 20
MILEPOST
189.49
4000′
79 MPH
543′
60 MPH
FORMER NORTHBOUND
MAIN TRACK RETIRED
BY ICG FROM ILES
NORTHWARD IN 1978
HAZEL DE
FORMER NORTHBOUND
MAIN TRACK RETIRED
BY ICG FROM ILES TO
K.C. JUNCTION IN 1975
PPENDIX
SPORTATION S
TRACK DIAGRA
GULF RAILROA
TRAK NO.21 –
00 FEET
ESTRICTIONS F



APPENDIX G

NATIONAL TRANSPORTATION SAFETY BOARD
ACCIDENT SITE AND TRACK DIAGRAM, ALTON DISTRICT
ILLINOIS CENTRAL GULF RAILROAD – SPRINGFIELD TO HAZEL DELL
DERAILMENT OF AMTRAK NO.21 – OCTOBER 30, 1980
SCALE: 1-INCH = 1,000 FEET
TIMETABLE SPEED RESTRICTIONS FOR PASSENGER TRAINS IN BRACKETS

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-828/33

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

**HEAD-ON COLLISION BETWEEN
BALTIMORE & OHIO RAILROAD COMPANY
TRAIN NO. 88 AND THE BRUNSWICK HELPER
NEAR GERMANTOWN, MARYLAND
FEBRUARY 9, 1981**

NTSB-RAR-81-6

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NTSB-RAR-81-6	PB81-218877	

4. Title and Subtitle	5. Report Date
Railroad Accident Report: Head-on Collision Between Baltimore & Ohio Railroad Company Train No. 88 and the Brunswick Helper 7603-7545 Near Germantown, Maryland, February 9, 1981	May 27, 1981
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594	10. Work Unit No. 3263
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594	13. Type of Report and Period Covered Railroad Accident Report February 9, 1981
	14. Sponsoring Agency Code

15. Supplementary Notes

The subject report was distributed to NTSB mailing lists: 8A, 8D and 14A.

16. Abstract

At 9:56 a.m. on February 9, 1981, Baltimore & Ohio Railroad Company's Brunswick Helper 7603-7545 and eastbound train No. 88 collided head-on while being operated in opposing directions on the No. 2 eastward main track. The trains collided in a 1°40' curve about 4,000 feet east of Germantown, Maryland. The fireman and front brakeman of No. 88, and the engineer and front brakeman of the Brunswick Helper were injured. Damage was estimated at $701,000.

The National Transportation Safety Board determines that the probable cause of this accident was the train dispatcher's oversight in authorizing the Brunswick Helper to operate westward on the No. 2 eastward main track between Gaithersburg and Rocks, while opposing train No. 88 was en route eastward on the same track. Contributing to the accident was an inadequate Baltimore & Ohio Railroad Company operating procedure which did not provide means for the train dispatcher and the tower operator to positively verify the location of all trains between Rocks and QN Tower, and did not provide for a backup system that would require coworkers to verify train locations when train orders are being used.

17. Key Words	18. Distribution Statement
Manual Block Operating Rules; Centralized Traffic Control; Traffic Control System; Helper Engine; Train Orders; Remote Interlocking; Current of Traffic; Train Dispatcher; Tower Operator; Train Radio; Environmental Conditions	This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	32	

NTSB Form 1765.2 (Rev. 9/74)

CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: May 27, 1981

HEAD-ON COLLISION BETWEEN BALTIMORE & OHIO RAILROAD COMPANY TRAIN NO. 88 AND THE BRUNSWICK HELPER 7603-7545 NEAR GERMANTOWN, MARYLAND, FEBRUARY 9, 1981

SYNOPSIS

At 9:56 a.m. on February 9, 1981, Baltimore & Ohio Railroad Company's Brunswick Helper 7603-7545 and eastbound train No. 88 collided head on while being operated in opposing directions on the No. 2 eastward main track. The trains collided in a 1°40' curve about 4,000 feet east of Germantown, Maryland. The fireman and front brakeman of No. 88, and the engineer and front brakeman of the Brunswick Helper were injured. Damage was estimated at $701,000.

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INVESTIGATION

The Accident

Train No. 88--At 9:03 a.m. on February 9, 1981, Baltimore & Ohio Railroad Company (B&O) train No. 88, en route from St. Louis, Missouri, to New York, with 3 locomotive units, 49 cars and 41 empty cars, for a trailing tonnage of 5,216 tons, left Brunswick, Maryland, after a satisfactory airbrake test. The engineer, fireman, and head brakeman were on the lead locomotive unit, which had the short hood forward, and the conductor and flagman were on the caboose. The fireman was operating the locomotive. The enginecrew had checked the radios on all units before leaving the Brunswick yard, and they were operating satisfactorily. No. 88 passed Rocks, Maryland, at 9:17 a.m., continuing on the eastward main track (No. 2 track) of the Metropolitan Subdivision (Metro SD). (See figure 1.) At Point of Rocks (Rocks), it left the jurisdiction of the Old Main Line (OML) dispatcher and became the responsibility of the Baltimore Terminal (Metro SD) dispatcher.

The assigned engineer of No. 88 left the operating compartment of the lead locomotive unit about 15 minutes at Barnesville, Maryland, 6.7 miles west of Germantown, to see if the dynamic brakes were functioning properly on the second and third units as the train descended a grade east of Barnesville. After having made the

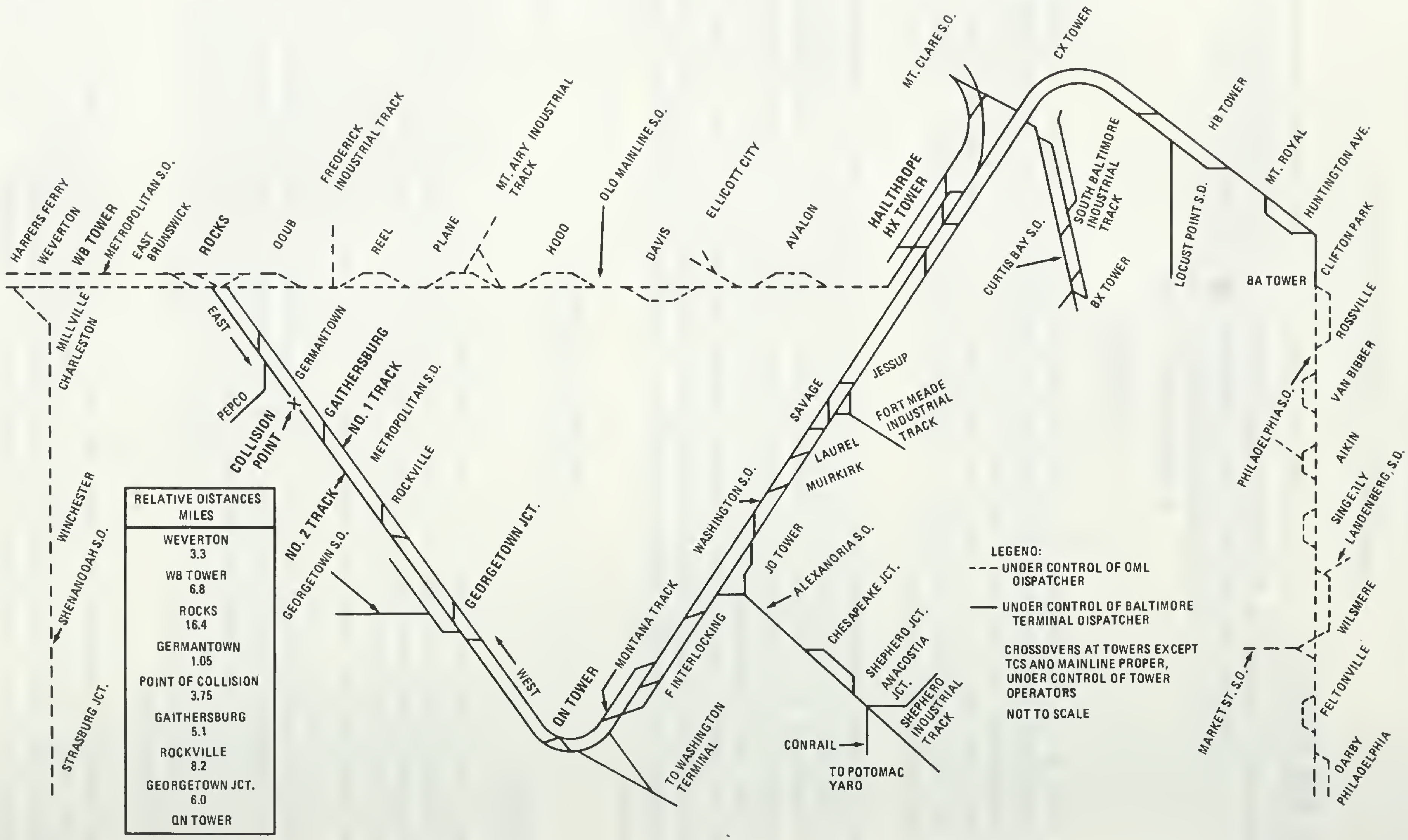


Figure 1.--Maryland Division--Baltimore District.

inspection, he was returning to the lead unit through the operating compartment of the second unit when he heard his fireman radio the conductor, in accordance with the rules, that train No. 88, eastbound on No. 2 track at Seneca Fill, had encountered an approach signal aspect. The engineer heard the conductor acknowledge this message, and he too used the radio in the second unit to acknowledge it. The fireman made a 6-pound airbrake reduction to slow the train from about 50 mph to about 25 mph to comply with the signal indication. The engineer remained in the operating compartment of the second unit after the radio transmission to observe the passing of a westbound freight train on the adjacent westward main track (No. 1 track). After entering a 1°40' curve, the fireman of No. 88 saw a locomotive from an estimated 250 feet approaching on No. 2 track. He immediately applied the train's brakes in an emergency application and started to leave the operating compartment through a door located directly behind the control stand. The engineer was preparing to leave the operating compartment of the second unit when he saw the fireman attempting to leave the lead locomotive unit's operating compartment and about the same time he too saw the approaching locomotive.

The Brunswick Helper. 2/--At 10:30 p.m. on February 8, 1981, the Brunswick Helper's crew, composed of an engineer and a brakeman, had been called for duty at Brunswick and were assigned locomotive units 7545 and 7603. When the crew boarded the locomotives, they tested the brakes and found no defects. They also checked the radios on each unit and found no fault with the radio on unit 7545. The speaker on the radio on unit 7603 was inoperable; however, the radio was fully operable by use of the handset. (According to B&O supervisors, an inoperable speaker causes the radio to be classified as inoperable, but there are no Federal or company rules to prohibit a locomotive from leaving a terminal with an inoperable radio.) After these checks, the Brunswick Helper began its assigned tasks of pushing trains over the steep grades on either the Old Main Line Subdivision (OML SD) or the Metro SD east of Brunswick.

On February 9, about 7:00 a.m., the Brunswick Helper returned to Rocks after assisting B&O No. 396 to Gaithersburg. The operator at WB Tower in Brunswick instructed the crew to assist Extra 4294 East from Rocks to Gaithersburg. After the Brunswick Helper had coupled to the caboose of Extra 4294 East and a satisfactory train airbrake test had been completed, which included the brakes of the helper locomotive, it departed from Rocks eastbound on No. 2 track at 8:43 a.m.

The B&O operating instructions require that a helper engine uncouple from the assisted train without causing it to stop. When Extra 4294 East reached Gaithersburg, the Brunswick Helper was uncoupled from the moving train without stopping it, in compliance with the operating instructions. After the Brunswick Helper came to a stop, the engineer reported his arrival at Gaithersburg at 9:30 a.m. by radio to the operator at QN Tower in northeast Washington, D.C. By this time, the Brunswick Helper had only 1 hour in which to return to Brunswick before it would exceed the 12-hour time limit imposed by the Federal hours-of-service regulation. If it exceeded the limit, the crew would have to be relieved immediately regardless of their location. Therefore, the company believed that it was urgent that the train return to Brunswick without delay in order to comply with the regulations. The operator at QN Tower asked the crew of the Brunswick Helper if they had met any westbound freight trains on No. 1 track before they arrived at Gaithersburg. When he was told that they had not and the operator had relayed this information to the dispatcher, the dispatcher told him to copy a 235D-R train order, which would allow the Brunswick Helper to return to Rocks on No. 2 track. (See appendixes B and C.) The dispatcher stated that he could not allow the Brunswick Helper to return to Rocks over the normal route via No. 1 track because he did not know the location of the two

2/ A helper engine is used to assist high-tonnage trains over steep grades.

westbound freight trains. (No attempt was made to contact the trains by radio to determine their locations.)

The operator at QN Tower instructed the engineer of the Brunswick Helper to use a local railroad block telephone to copy a train order. The train order, relayed from the train dispatcher to the Brunswick Helper through the operator at QN Tower, was transmitted and repeated satisfactorily; it was made complete at 9:43 a.m. The dispatcher told the operator at QN Tower to give the Brunswick Helper a "verbal clear block" 3/ on No. 2 track from Gaithersburg to the West Absolute Signal (WAS) at Rocks. Since the helper would be operating against the established current of traffic, it would not have wayside signal aspects to indicate the condition of the track ahead to WAS Rocks.

When the train order was given to the Brunswick Helper and the train was given the verbal clear block information, neither the operator nor the engineer mentioned or questioned the location of No. 88. At this point, the engineer and brakeman moved from unit 7545 to unit 7603 and the Brunswick Helper departed westbound from Gaithersburg on No. 2 track about 9:45 a.m. on the authority of train order No. 107. (See appendix B.) The engineer was operating the locomotive from the northside of the operating compartment and the brakeman was seated on the southside. The short hood was facing forward. Except for reducing the locomotive's speed to 30 mph over two facing point switches, the speed was maintained about 35 mph.

As the Brunswick Helper entered a 1°40' curve to the right near Germantown, the engineer saw a locomotive approaching head on from about 750 feet. He immediately set the locomotive's brakes in emergency, and he and the brakeman jumped from the walkway of the locomotive and landed between the two main tracks.

The Collision.-- Train No. 88 and the Brunswick Helper collided about 9:56 a.m. (See figure 2). The speed of No. 88, as recorded by the speed recorder on the first and third locomotive units, was 24 mph at impact. The speed of the Brunswick Helper, as recorded on the speed recorder of the second locomotive unit, was between 35 mph and 40 mph. The track grade averaged 1.05 percent descending eastward through the area of the accident.

When the trains collided, the lead unit of No. 88 was elevated to an almost vertical position. It pivoted on its west end and fell toward the north across the No. 1 track. The second unit of No. 88 overrode the lead unit of the Brunswick Helper, and the third unit and the first car behind the locomotive derailed. Both units of the Brunswick Helper were moved eastward about 300 feet from the point of impact, but only the lead unit derailed.

When the lead unit of No. 88 overturned, it landed on a low bank and fell on the engineer from the Brunswick Helper and pinned him so that he could not free himself. The brakeman of the Brunswick Helper and the engineer of No. 88 were not seriously injured, and they were able to free the engineer. (See figure 2.)

3/ A clear block is defined in the Chessie System Operating Rules as, "A term used in connection with Manual Block System Rules indicating the block is clear of trains authorized to move in the same direction as the train addressed. The Operating Rules relating to train dispatchers also specify that, "When trains are to be moved against the current of traffic, train order Rule 235 D-R must not be made complete to the train(s) to be moved against the current traffic until the section of track on which the train is to run has been cleared and is maintained clear of all opposing train movements [except train(s) specified in Rule 235 D-R Example (2)] within the designated limits until the diverted train(s) has arrived."

Figure 2.--Scene of accident.

After the collision, the fireman of No. 88 was seen alternately sitting and lying on the side of the overturned locomotive unit. The head brakeman was pinned inside the operating compartment of the lead unit. The fuel tanks of each lead locomotive unit ruptured, and some of the crewmen and the surrounding area were saturated with fuel oil. Fire erupted with a loud explosion, and residents of a nearby community heard the crash and explosion and called local emergency forces. Local fire departments responded promptly and had the fire under control quickly. Also, local rescue squads and the Maryland State Police medical helicopters arrived at the scene quickly. The injured were treated and then removed to nearby medical facilities.

Handling of the Trains.--The Baltimore Terminal train dispatcher, who directs train movements and operations on the B&O 4/ Metro SD, began his tour of duty about 6:30 a.m., on February 9, after a routine "situation" transfer from the 11:00 p.m. dispatcher. The transfer procedure included a review of the train sheet, the storage tracks for cars that were being held, the tracks that were out of service, the train order books, the locations of maintenance-of-way personnel, and any other items affecting train movements.

About 7:23 a.m., commuter train No. 52, en route from Brunswick, Maryland, to Washington, D.C., over the Metro SD, reported to the operator at QN Tower that there was a broken rail on the No. 2 track about 500 feet west of Georgetown Junction. (Georgetown Junction is an interlocking installation near Silver Spring, Maryland, which is remotely controlled by the operator at QN Tower.) The broken rail information was relayed to the Baltimore Terminal train dispatcher. Four eastbound commuter trains, Nos. 60, 40, 702, and Amtrak No. 32, were scheduled to pass over the broken rail within the next hour and a half. Additionally, Extra 4294 East, assisted by the Brunswick

4/ B&O is part of the Chessie System.

Helper, had passed Rocks at 8:43 a.m., and train No. 88 was at Brunswick. The dispatcher issued instructions through the operators at WB Tower and QN Tower for the passenger trains to pass over the broken rail at 5 mph.

However, the engineer of No. 60 reported to the operator at QN Tower that in his judgment it would not be safe for No. 702 to move over the broken rail. No. 40 had already passed the last available crossover point, and since it was composed of lightweight equipment, it proceeded on No. 2 track over the broken rail without mishap. Based on the rail's condition as reported by train No. 60, the dispatcher made arrangements to operate Nos. 702 and 32 eastbound on the westbound No. 1 track between the crossovers at Rockville, Maryland, and Georgetown Junction. Before this could be done, the dispatcher had to wait for an eastbound train to arrive at Georgetown Junction which earlier had been given a train order to operate on No. 1 track from Rocks to Georgetown Junction to avoid delaying it and the commuter and Amtrak trains on No. 2 track.

The dispatcher then instructed the operator at QN Tower to hold two westbound trains clear of No. 1 track at Georgetown Junction, after the eastbound train arrived. He also instructed the operator at WB Tower to notify Extra 4294 East via radio to call the operator at QN Tower from Rockville in case it was necessary to reroute the train. The dispatcher then completed his predeparture instructions to No. 88 through WB Tower and told the operator to instruct No. 88 to call the operator at QN Tower from Rockville again in case it had to be rerouted. The operator at WB Tower reported to both dispatchers that No. 88 departed from Brunswick at 9:03 a.m. eastbound on No. 2 track after the OML dispatcher determined from the Baltimore Terminal dispatcher that it was alright for the train to leave. Appropriate train orders were issued to trains No. 702 and 32, and they were allowed to leave Rockville on No. 1 track. When No. 32 arrived at Georgetown Junction, the dispatcher released the two westbound freight trains about 9:10 a.m.

About 9:30 a.m., the operator at QN Tower told the dispatcher that the Brunswick Helper had arrived at Gaithersburg. At that time, the dispatcher decided to move the Brunswick Helper back to Rocks on the No. 2 track. As he prepared for the return of the Brunswick Helper from Gaithersburg to Rocks on the No. 1 track, the Baltimore Terminal dispatcher asked the collocated OML SD dispatcher to give him a stop signal eastward on No. 2 track at Rocks. When the request was made, the OML dispatcher was talking on a Bell System telephone and he held his hand up, indicating "wait a second." Nevertheless, he understood what was asked, and he properly aligned the track switches and the direction of traffic at Rocks, and blocked the signal and switch levers on the control machine to provide the maximum protection for the proposed movement. The Baltimore Terminal dispatcher recorded only "SD (stop displayed) east at KG (Rocks)" in his train order book. Neither the OML dispatcher nor the Baltimore Terminal dispatcher mentioned to each other that No. 88 was the last train past Rocks at 9:17 a.m. on track No. 2.

Injuries to Persons

Injuries	Crewmembers Train No. 88	Crewmembers Brunswick Helper	Total
Fatal	0	0	0
Nonfatal	2	2	4
None	3	0	3
Total	5	2	7

Damage

The Brunswick Helper's lead unit was demolished when it was overridden by No. 88's second unit. The operating compartment and the components under the short hood were destroyed. (See figure 3.) The second unit of the Brunswick Helper was damaged only slightly.

The operating compartment of No. 88's lead unit was crushed and the unit overturned onto its side; it was heavily damaged. The operating compartment of the second unit was crushed badly and was damaged heavily. The third unit was damaged only slightly. One car in No. 88 derailed with no significant damage. The distribution of damage was:

Item	Damage
Equipment	$ 686,600.00
Track	1,000.00
Rerailing costs	13,335.35
Total	$ 700,935.35

Crewmember Information

The crewmembers of the Brunswick Helper were on the extra list from which helper crews are called. The engineer and brakeman had been off duty 27 hours and 28 hours, respectively, before reporting for duty on February 8. They were qualified for their positions in accordance with company requirements.

The five-member crew reported for duty at 8:00 a.m. on February 9, at Brunswick, to operate train No. 88 from Brunswick to Baltimore. They had been off duty 10 hours 45 minutes since their arrival at Brunswick on a westbound train the previous day. Each person was qualified for his position in accordance with company requirements.

The crewmembers from both trains had been trained for their positions by on-the-job training, except for the fireman of No. 88 who had attended the Chessie System's engineer training school at Cumberland, Maryland. His training lasted 6 months, including 5 weeks of 6 days per week of classroom instruction.

Train Dispatcher and Operator Information

The Baltimore Terminal train dispatcher regularly works a relief assignment at Baltimore. His assignment is: 2 days from 7:00 a.m. to 3:00 p.m., 2 days from 3:00 p.m. to 11:00 p.m., and 1 day from 11:00 p.m. to 7:00 a.m. His rest days are Saturday and Sunday, but they run from 7:00 a.m. Friday until 7:00 a.m. Monday. On Monday, February 9, he had reported for duty at 6:20 a.m. following his two rest days. He qualified for his position as train dispatcher by on-the-job training and working as a tower operator at several locations on the Maryland Division for about 10 years.

Similarly, the OML train dispatcher works a relief position with his rest days on Friday and Saturday. He also qualified for his position as train dispatcher by on-the-job training and by working as a tower operator for about 12 years. He reported for duty about 6:20 a.m. on February 9, and began working about 6:30 a.m. His transfer routine is similar to that of the Metro SD dispatcher.

Figure 3.--Brunswick Helper. Damage to Unit 7603.

The tower operators at WB and QN Towers began their tour of duty at 7:00 a.m. on February 9, and they were scheduled to work until 3:00 p.m. Each operator had been off duty 16 hours since his previous tour, as required by the Federal hours-of-service regulations. Each qualified for his respective position by on-the-job training. (See appendix D.)

Train Information

The locomotive assigned to the Brunswick Helper consisted of two Electro-Motive Division (EMD) General Motors Corporation model SD-40 units -- 7603 and 7545. Unit 7603, the lead unit westbound, had a low-profile short hood with the control stand on the right side. It was equipped with a speed indicator/recorder, a 26-L schedule airbrake system, and a radio. The unit was not equipped with an alertor device or a deadman control. 5/ The locomotive weighed 780,700 pounds.

Train No. 88 consisted of one EMD model GP-40 unit, one EMD model GP-35 unit, and one EMD model GP-38 unit (units Nos. 3773, 3815, and 3550, respectively). The GP-40, unit 3773, was added to the train at Brunswick as the lead unit, and it had a low-profile short hood with the controls on the right side. It was equipped with a speed indicator/recorder, a 26-L schedule airbrake system, and a radio. The unit did not have an alertor device or deadman control. The locomotive weighed 806,000 pounds.

5/ Alertor—A device to detect physical movement of an engineer. If a movement is not detected by the device within a predetermined time, a warning signal will sound and if it is not acknowledged by the engineer, the train will be stopped.
Safety Control—A safety device that must be depressed at all times during train movement to forestall an automatic brake operation. It is generally known as a deadman control.

Method of Operation

On March 12, 1961, the B&O consolidated three dispatching districts into two dispatching districts after a train control system (TCS) was put into service between Rocks and Philadelphia, Pennsylvania.

The OML SD, part of the Maryland Division, begins at Rocks, 6.9 miles east of Brunswick, and extends eastward 59 miles to HX Tower at Baltimore. The OML dispatcher directs train movements on the Metro SD between Weverton, Maryland, and Brunswick, and from East Brunswick to Rocks, except for those interlocking installations at WB Tower and East Brunswick which are controlled by the operator at WB Tower. The TCS begins at Rocks. Using the TCS console, the OML dispatcher controls the signals and switches at Rocks, which routes trains either to or from the Metro SD from the OML SD. The TCS extends eastward from Rocks 23.6 miles to East Plane, Maryland. Between East Plane and HX Tower, 35.4 miles, there is a segment of manual block track where trains must operate by train orders. TCS operation is resumed at BA Tower in East Baltimore where the OML dispatcher begins control of the Philadelphia subdivision between Baltimore and Philadelphia. Because he controls the Philadelphia subdivision, he is sometimes referred to as the Eastend dispatcher.

In addition to the OML SD and the Philadelphia subdivision, the OML dispatcher also controls train movements on the Shenandoah subdivision, between Harpers Ferry, West Virginia, and Strasburg Junction, Virginia, and on the Landenberg and Market Street subdivisions. These areas of control give him a total of 221 miles of operational responsibility.

During December 1980, 112 trains moved east and 25 trains moved west over the OML SD. During January 1981, 66 trains moved east and 37 trains moved west. Over the Philadelphia subdivision, during December 1980, 114 trains moved east and 100 trains moved west; during January 1981, 112 trains moved east and 104 trains moved west. These trains represent the combined traffic load of the OML SD dispatchers.

The Metro SD, also a part of the Maryland Division, extends eastward from Weverton, through Rocks, 42.2 miles to Washington, D.C. The Baltimore Terminal dispatcher directs the operation of trains between Rocks and QN Tower and train movements are controlled by the signal indications of an automatic block signal system, train orders, and bulletin orders (rules D-251 to D-254). (See appendix C.) When trains are operated against the established current of traffic, Manual Block System rules are in effect (rules 97 and 300 to 327). The two main tracks of the Metro SD between Rocks and QN Tower are numbered north to south as No. 1 for westbound traffic and No. 2 for eastbound traffic. In addition, the Baltimore Terminal dispatcher has jurisdiction over trains on the two-track Washington subdivision, which extends from F interlocking in Washington to HX Tower and the Baltimore Terminal. (See figure 1.) The Baltimore Terminal includes a section of the OML SD between HX Tower and Curtis Bay Junction in Baltimore, the Mt. Clare, the Curtis Bay, and the Locust Point subdivisions; a section of the Philadelphia subdivision between BA Tower in Baltimore & HB Tower; and the Georgetown and the Alexandria subdivisions. He has control over B&O trains entering and leaving Union Station of the Washington Terminal Company in Washington, D. C. He also operates a small centralized traffic control unit for Jessup, Maryland. In all, he oversees train operations on 109.4 miles of track.

During November 1980, 253 eastbound trains and 334 westbound trains moved over the Metro SD; during January 1981, 234 eastbound trains and 257 westbound trains moved over the subdivision. About seven tower operators are under the supervision of the Baltimore Terminal dispatcher, and several agent-operators receive instructions from him.

The trains operating over the Metro SD are equipped with radios, but the Baltimore Terminal dispatcher does not have a radio. Radio messages to and from trains and the dispatcher must be relayed through the tower operators.

When an eastbound train leaves Brunswick for Baltimore, it may be routed from Rocks over either the OML SD or the Metro SD. In most instances, specified trains or types of trains are dispatched regularly over the same subdivision. However, there are times when circumstances dictate a change of routing after a train has left Brunswick. When this happens, the operator at QN Tower often is not told of such a change, and he does not know what to expect when a train approaches his location. Normally, when it is known that a given train will be routed over the OML SD, it will be "cleared" at WB Tower by the OML dispatcher. When the train leaves Brunswick, the operator at WB Tower will report the departure time to the OML dispatcher only. If it is known that a train will be routed over the Metro SD, the Baltimore Terminal dispatcher will issue messages pertinent to the train's operating over his subdivision, and the OML dispatcher will "clear" the train with WB Tower. When the train is ready to leave Brunswick, the OML dispatcher will ask the Baltimore Terminal dispatcher if it is alright to let the train leave. When approval is given and the train leaves Brunswick, the operator at WB Tower will report its departure to both train dispatchers. In addition, the operator at WB Tower will call the operator at QN Tower to tell him that the train is entering his traffic block. When a train leaves Brunswick and is routed over the Metro SD, the only other reporting point between Brunswick and QN Tower is Rocks. The OML dispatcher has an annunciator indicator light and a bell at Rocks, both of which are activated by a train's presence. Although he records the time a train passes that point, he does not report this time to either the operator at QN Tower or the Baltimore Terminal dispatcher, unless a train is moving onto or out of the Metro SD that did not originate at Brunswick or will terminate at Brunswick. The two dispatchers are neither required nor prohibited from exchanging passing times at Rocks with each other or with the operators at QN, HX, or WB Towers.

When helper engines are required, they push trains from Rocks to Waterville, Maryland, on the OML SD or to Gaithersburg on the Metro SD. The helper locomotive is coupled to the trains at either Brunswick or Rocks. When the coupling is made, the airbrake system of the helper locomotive is coupled to the airbrake system of the train to be pushed, and the brakes are controlled by the engineer of the pushed train. When the helper locomotive uncouples from the pushed train at Gaithersburg, it returns to Rocks or Brunswick after receiving proper authority from the train dispatcher. The normal return route for the helper is for it to move over a crossover at Gaithersburg from No. 2 track to No. 1 track and then continue west to Rocks. Helper service is not required westbound. It is an accepted practice for the helper crew to report to the operator at QN Tower its arrival time at Gaithersburg, and the last westbound train it has met.

The maximum authorized speed on the Metro SD is 55 mph moving with the current of traffic and 35 mph moving against the current of traffic.

Meteorological Information

The weather conditions reported by the National Weather Service, Washington, D.C. at 9:52 a.m. on February 9, 1981, at the Washington National Airport were:

Sky condition	Clear
Visibility	20 miles
Temperature	30° F
Dewpoint	12° F
Wind direction	300° (west-northwest)
Wind speed	13 knots, gusting to 23 knots

Survival Aspects

The Brunswick Helper's crew escaped serious injury from impact by jumping from the locomotive. Their injuries were sustained when they landed on the ballast, cross ties, and rails of No. 1 track. The engineer suffered multiple fractures to his pelvic bone, but he had only cuts and abrasions on his head as a result of his being pinned by the locomotive unit. The brakeman also received cuts and abrasions when he landed on and rolled about on the rough track surface. He also was burned chemically by the fuel oil, but not by the fire. The engineer and brakeman were taken by ambulance to Germantown Hospital for emergency treatment. The brakeman was treated and released, but the engineer was transferred and admitted to the Suburban General Hospital in Bethesda, Maryland.

The engineer of No. 88 was not injured. During the collision, the fireman managed to hang onto the grab iron at the door of the locomotive operating compartment of unit 3815. The engineer saw him holding on at that point when the unit was rearing and pivoting on its west end. He apparently was able to remain outside the operating compartment and to maintain his grip until the locomotive unit toppled onto its side. He broke his left hip and the femur bone of his left leg in several places.

The brakeman remained in the bottom of the operating compartment of the lead unit as it lay on its side until he was removed by rescue workers. He had a severe concussion from a blow to the head. He also received cuts and abrasions.

The fireman and front brakeman of No. 88 were flown by Maryland State Police helicopter to University Hospital in Baltimore where they were admitted to the shock trauma unit. The conductor and flagman were not injured.

Tests and Research

On February 19, tests were conducted to establish sight distances for the curve on which the trains collided. Locomotive units similar to the units involved in the collision were used and were oriented in the same position and direction as those of the accident trains. Tests simulated the view from each train to the other. (See figures 4 and 5.)

Since it was destroyed in the collision, the speed recorder on unit 3773 could not be calibrated. On February 14, the recorder on unit 3550 of No. 88 and the recorder on unit 7545 of the Brunswick Helper were tested to determine their accuracy. The results are shown below.

Table 1.--Speed Recorder Test Results

Recorder from Unit	Test Speed Generated (mph)	Speed Recorded (mph)
7545	7	7
	40	40
	55	56
3550	7	6.25
	40	40
	56	58

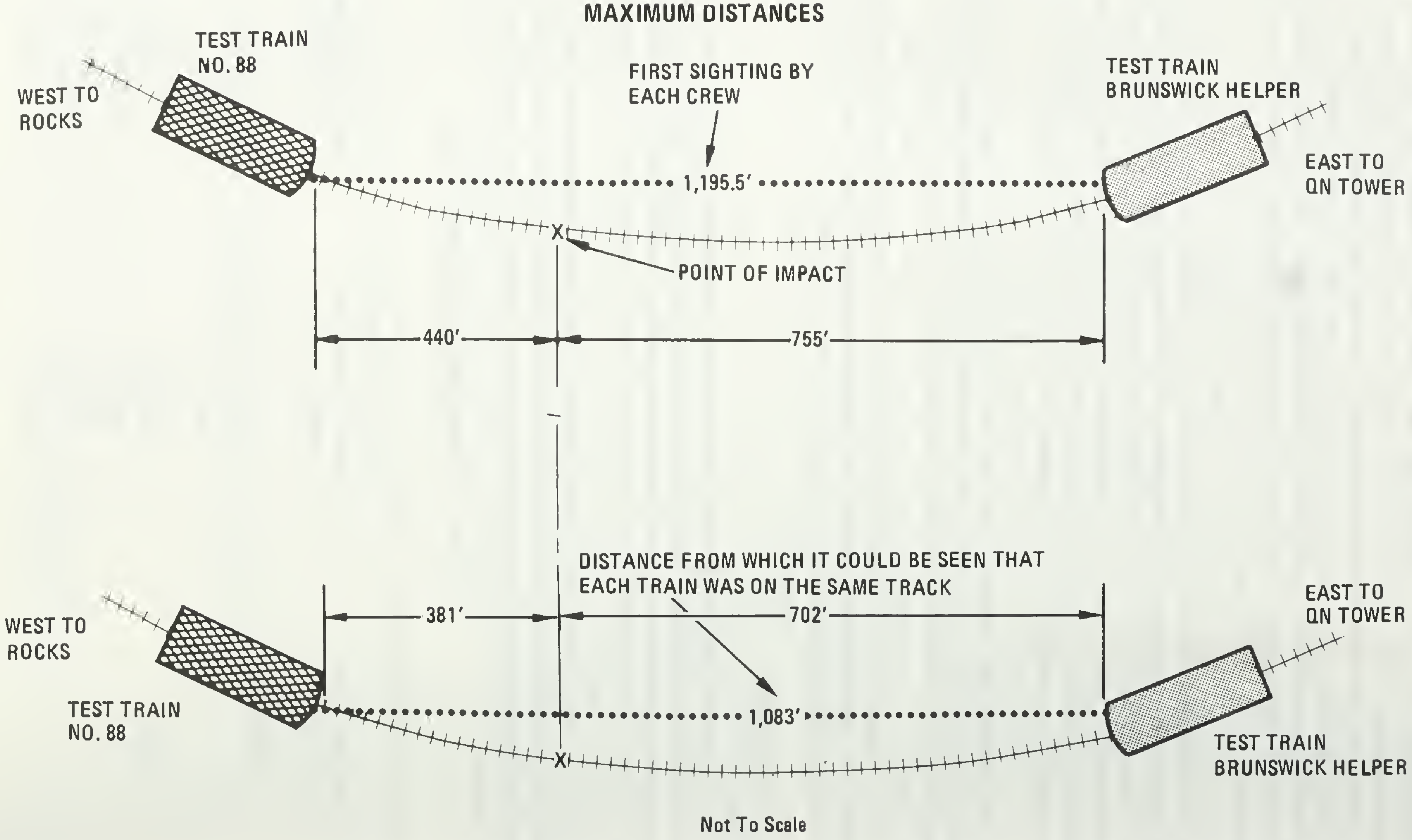


Figure 4.-- Sight distance as determined by test trains.

Figure 5.--View of train No. 88 from the Brunswick Helper (simulation).

Other Information

Following the accident, the OML and the Baltimore Terminal dispatchers expressed concern to the Safety Board about their working environments. According to the dispatchers, the office in which they work is poorly ventilated. The air conditioning is difficult to regulate during the warm months, and the heat is difficult to regulate during cool months. At times, the two systems must be run simultaneously to obtain a tolerable temperature. They also expressed concern about distraction. The two dispatchers are located in one end of a large room. A partition with no doors extends about two-thirds across the room and separates the dispatchers from a larger work area. Access to the two dispatchers is not restricted, and noise from the outer area is only slightly attenuated. A partial glass partition separates the two dispatchers. The Baltimore Terminal dispatcher faces this partition and looks through it to see the OML dispatcher. On occasion, he can see the annunciator light on the TCS console and knows when a train is passing Rocks. The OML dispatcher sits partially enclosed inside the wings of the TCS console. Both dispatchers have a dispatcher's telephone system with an open speaker through which amplified communications or line noises radiate continuously. The Baltimore Terminal dispatcher stated that at times his telephone system is extremely noisy and weak and that frequently a communication will be interrupted by another party because the party fails to detect that the line is being used.

The lavatories are located outside the working area down a hallway from the dispatcher's office, and the dispatchers have no one to take over their positions if they must use the lavatories. As a result they are forced to remain in the work area and often become quite uncomfortable. Both traincrews and operators stated that radio reception is poor between Barnesville and Gaithersburg. Transmissions from the operator at QN Tower usually cannot be received west of Gaithersburg, and transmissions from the

operator at WB Tower cannot be received east of Barnesville. Radio transmitter stations are located at WB Tower and at QN Tower, and there are no repeater stations between these points. Only one channel is used by trains on the main line, although the locomotive radio units are equipped with four channels.

On March 13, 1981, the Superintendent of Operations of the B&O's Maryland Division issued special instructions to the Baltimore Terminal and OML dispatchers, and to the operators at QN and WB Towers, outlining new procedures for moving trains past Rocks and against the current of traffic between QN Tower and Rocks. (See appendix E.)

ANALYSIS

The Accident

The two train crews involved in the accident were operating their trains in accordance with the operating rules. Both trains were being operated properly at or near the speed limit. Since the sight distance available to each engineer was minimal because of the track curvature, the Safety Board concludes that their attempts to stop when the opposing train was sighted, by immediately making an emergency brake application, were unavailing. Although neither train was equipped with an alertor or a safety control device, these safety devices would not have been of assistance in this situation.

The operator at WB Tower gave the Baltimore Terminal dispatcher the departure time for No. 88 from Brunswick. Therefore, he had been advised that the train was approaching his subdivision. However, just before No. 88 left Brunswick, the dispatcher had been busy issuing train orders to move trains around a broken rail near Georgetown Junction. Just after No. 88 left Brunswick, he became concerned with the problem of getting the Helper's crew back to Brunswick so they would not have to be relieved en route from Gaithersburg. In addition to this activity, he was simultaneously supervising train operations and giving train movement information to maintenance-of-way personnel on the Washington subdivision and the Baltimore Terminal. When he decided to allow the Brunswick Helper to return to Rocks on No. 2 track, he was concerned about the two westbound freight trains approaching Gaithersburg. He could not and did not want to risk stopping them because of delay to them and the inherent danger in an emergency stop. Therefore, he gave instructions to the operator at QN Tower to copy the train order for the Brunswick Helper. When the Baltimore Terminal dispatcher was preparing to issue the train order to the operator at QN Tower, he did not ask him about No. 88 and the operator did not question the dispatcher as to the train's location. Since the two dispatchers frequently divert trains from the Metro SD to the OML SD at Rocks and do not inform the operator at QN Tower of their actions, and since the dispatcher had not mentioned No. 88 to him, the operator assumed that the train had been diverted and he did not mention it. Before the train order was issued and made complete, the dispatcher did not comply with the rule addressing the train dispatcher's responsibility to determine the condition of the traffic block in which he was planning to move a train against the current of traffic. If the operator at QN Tower had been kept advised of a train's location, as a backup precaution, he may have raised questions to the dispatcher about the location of No. 88.

When the Baltimore Terminal dispatcher asked the OML dispatcher to hold all eastbound trains at Rocks, he did not ask for the identification of the last train past that point, or for the time it passed Rocks eastbound on No. 2 track onto the Metro SD. Neither he nor the OML dispatcher mentioned that the last train past Rocks eastbound was No. 88. Probably because of his involvement in other work situations, the Baltimore Terminal dispatcher overlooked No. 88. The Safety Board believes that the dispatcher

overlooked No. 88 because his area of responsibility was large. Also, the series of events the dispatcher had to deal with before the accident imposed temporary stress on him. However, this is not unusual because many times during a workday, situations develop that temporarily impose a workload on the train dispatcher that one person could not deal with continuously. The operating procedure did not provide adequate backup measures that would insure a system that would serve as an adjunct to the dispatcher's maintaining a knowledge of a train's location.

When the three dispatching districts were consolidated, the territories for which the two train dispatchers were responsible were increased. Both dispatchers are constantly having to shift their attention from one area of their subdivision to another, always having to keep in mind what is occurring at some other location. In order to control trains properly and safely, they must know the locations of each train, locomotive, or piece of track equipment at all times. Frequently, a train dispatcher is required to give traffic "line-ups" to maintenance-of-way personnel or construction workers working on or near the railroad right-of-way, so he must have a thorough knowledge of train movements and locations. The Safety Board believes that the tower operators who work under the supervision of each dispatcher could and should help dispatchers accomplish this task by reporting promptly the times trains pass their locations or by keeping the dispatchers advised of unusual circumstances or events. Also, the dispatchers should inform tower operators when a train is approaching their stations, if it has been delayed, diverted, or is emerging from a long block.

When the three dispatching districts were consolidated, the OML dispatcher was given a larger area to supervise and a TCS by which to control the movement of trains over his territory. The method by which he exercised control was changed, giving him greater flexibility and decreasing his dependence on coworkers to report train locations. Since he controls train movements almost completely from the TCS console, except for those subdivisions where operation by train orders is required and the segment of the OML SD where Manual Block Rules apply, his ability to keep himself aware of train movements is greatly enhanced.

After the consolidation, the Baltimore Terminal dispatcher was assigned considerably more territory over which he had to control train movements, but TCS was not installed. The subdivisions over which he was given responsibility required his close supervision because of the frequent need for the issuance of train orders. This situation made his task much more difficult than the OML dispatcher's because it required him to work constantly with tower operators. He also had the added responsibility of moving passenger and commuter trains on two subdivisions during the early morning and evening hours. When there are no unusual circumstances between QN Tower and Rocks, trains operate over the Metro SD by the indications of wayside signals on an assigned track in an assigned direction. However, the potential for problems is ever present, often created by the requirement for helper service between Rocks and Gaithersburg and commuter traffic. The traffic density on the Metro SD exacts heavy demands on the dispatcher and the job. Therefore, the Safety Board concludes that the dispatcher must be given all assistance possible to keep him informed, at all times, of the locations of the trains for which he is responsible.

The method of operation that was in effect between Rocks and QN Tower at the time of the accident was not conducive to a dispatcher's knowing the locations of all the trains for which he is responsible. When a train leaves Brunswick, the operator at WB Tower reports its departure to the Baltimore Terminal dispatcher. Through on-the-job

experience with locomotive engineers, the tonnage a train is hauling, the number and types of locomotive units in the train, and weather conditions, the dispatcher can closely estimate the time a train will take to move between two points. For example, the average running time between Brunswick and Gaithersburg is 1 hour. When a train is delayed, the running time is extended and the dispatcher must incorporate the events or circumstances into a new calculation of running time. Therefore, a dispatcher must know when each station has been passed. Since the OML dispatcher, at the time of the accident, did not report to the Baltimore Terminal dispatcher or to the operator at QN Tower the times trains passed Rocks onto the Metro SD, the trains were not accounted for again until they came onto the approach circuit of the interlocking installation at Georgetown Junction. Since the dispatcher was not normally advised of this event, he received only a passing report from QN Tower when a train passed QN Tower. If a train routed via the Metro SD was delayed between Brunswick and Rocks, the Baltimore Terminal dispatcher might not know of it. The Safety Board believes that B&O management should analyze the potential hazards inherent in this method of operation and take steps to correct unsafe operating procedures and conditions.

The maximum utilization of manpower would help to keep the Baltimore Terminal dispatcher better informed of train locations. During the daylight hours, an agent is on duty at Rockville and Silver Spring, and an agent is on duty part of the week at Gaithersburg. Although the agent at Rockville primarily works with the construction forces of the Washington Metropolitan Area Transit Authority, all these agents could be used to report the passing of trains at their stations. In addition, the Safety Board believes that the OML dispatcher should be required to report to the Baltimore Terminal Dispatcher the time a train passes Rocks eastbound or westbound, and one of the dispatchers should be required to report this same information to the operator at QN Tower or to whichever tower or station the train has or will pass.

If the OML dispatcher had given the passing time of No. 88 at Rocks to the Baltimore Terminal dispatcher or if the passing time had been routinely given by one dispatcher to the operator at QN Tower or to one of the intermediate agent-operators, the Baltimore Terminal dispatcher probably would not have overlooked No. 88. One other safeguard that may have prevented the accident would have been for the OML dispatcher to have received a copy of the 235 D-R train order issued to the Brunswick Helper. Concise operating rules or practices that are worded to afford guidance in dealing with usual or unusual problems are invaluable to any train dispatcher. The application of operating rules becomes second nature to a well trained, well disciplined dispatcher. Often a dispatcher is called upon to quickly extrapolate from two or more rules or operating practices to reach a decision as to the proper course of action in a given set of circumstances. When a train dispatcher is not provided with concise operating rules or practices, or if he is not provided with all the available information as to a train's location, he may be handicapped in the execution of his responsibilities, thereby increasing the already stressful task. Therefore, the Safety Board concludes that B&O management should insure against potentially confusing situations by providing clear guidance and continually instructing dispatchers and other operating employees on operating rules and procedures.

When the operator at QN Tower relayed train order No. 107 to the Brunswick Helper, the engineer did not question the operator as to the status of No. 88. The engineer stated after the accident that he thought No. 88 was ahead of the train he had assisted to Gaithersburg. When the train order was issued, No. 88 had not reached the signal at Seneca Fill and the fireman had not transmitted a radio message that would have identified No. 88 and its location. Thus, the crew of the Brunswick Helper was not alerted

to No. 88's presence. They apparently did not hear No. 88 make any radio broadcasts from points west of Seneca Fill even though the radio on unit 7545 was operable. The train order that gave the Brunswick Helper precedence over eastbound trains from Gaithersburg to Rocks and the verbal "clear block" message given the engineer by the operator, undoubtedly caused the engineer to dismiss any conflicting movements. A variation of the 235 D-R train order could have been used which would have specified that "after No. 88 engine 3773 arrives at Gaithersburg...." An order in this format may have prevented the accident if it had been used even when No. 88 was past Gaithersburg, because the Brunswick Helper would have had to know No. 88's location before it could move. No. 88's location could have been established either verbally or in the train order.

In summary, the accident could have been avoided if: a more inclusive and positive train reporting system had been in effect; the workers involved in the incident had assumed more responsibility in making crosschecks on train locations; rules had been concise and clear and more specific in regard to this type of operation; the dispatcher had complied with the operating rule addressed to the dispatchers relative to determining that the section of track between Rocks and Gaithersburg was clear of opposing trains; and the radio equipment on Helper unit 7603 has been fully operable.

The B&O management in Baltimore, which is responsible for train operations on the Maryland Division, was found to be responsive to ineffective operating practices involved in an accident. If an operating practice or rule is either found to be or believed to be involved as a causal factor in an accident or if it is one that failed to prevent an accident, B&O management has immediately taken action to correct the practice or rule, as evidenced by the procedural change made after this accident. (See appendix E.) B&O demonstrated this same responsiveness after an accident at Orleans Road, West Virginia. 6/ After that accident, the B&O began requiring the engineer to radio the conductor on the rear and inform him of the signal aspect his train was approaching and identify the train, its direction, the track it was using, and the signal location. The Safety Board commends such responsive actions but suggests that a comprehensive analysis of operating practices and procedures might reveal operating inadequacies and lead to the correction of currently unidentified ones.

Ineffective Rules and Practices

The definition of a clear block, as set forth in the operating rules, does not specify that the block must be clear of opposing trains, only clear of trains moving in the same direction. Awareness of implications of opposing traffic is so fundamental to safe dispatching and train movements that it should be self evident; however, as an additional safety margin, clear and unambiguous rules are essential. If the rule had clearly included opposing trains, it might have triggered a response from either the dispatcher, operator, or engineer, especially if it had been required of them that they recite the last eastbound and westbound trains past the limits of the train order authorization. The Safety Board addressed the problem of inconsistent and ambiguous operating rules in its Special Study, "Signals and Operating Rules as Causal Factors in Train Accidents, NTSB-RSS-71-3." The Safety Board believes that when ambiguities in operating rules are revealed during operations, they should be revised to remove the inconsistency.

6/ Railroad Accident Report--"Head-on Collision of Baltimore & Ohio Freight Trains Extra 6474 East and Extra 4367 West, Orleans Road, West Virginia, February 12, 1980." (NTSB-RAR-80-9.)

When the fireman of No. 88, in compliance with the operating rules, radioed his conductor that No. 88 had an approach signal aspect at Seneca Fill, he gave the train's identification, the train's direction, and the track number upon which it was operating. If the radio speaker on the Brunswick Helper's unit 7603 had been operable, the Brunswick Helper's crew could have heard the message and initiated action which could have prevented the accident. As the result of other accident investigations, 7/ the Safety Board has cited instances where train radios have been or could have been crucial in either preventing an accident or reducing its severity. Railroad management should not allow a train to leave a terminal with an inoperable radio or an inoperable radio component. The radio speaker is a vital part of the on-board system because it provides a monitoring capability for the enginecrew. In this accident, the volume of radio message traffic would have been relatively light in the area between Barnesville and Gaithersburg because of the limitations in the area of radio coverage. Also, since the Brunswick Helper was used locally to give assistance to heavy tonnage trains, these two factors would have made it likely that the operable speaker would have been instrumental in preventing the accident because the helper crew probably would have heard the radio broadcast made by No. 88.

Survivability

The crushing of the locomotive operating compartment of the Brunswick Helper's unit 7603 in the collision resulted in an unsurvivable environment. If the two-man crew had not jumped they would not have survived the crash. Fire erupted explosively from the spilled fuel oil from the punctured fuel tanks, probably as a result of electrical arcing when the unit was overriden. The operating compartment of No. 88's units 3773 and 3815, though badly crushed, were survivable environments. Crushing and destruction damage was probably not as great as it would have been if the Brunswick Helper had been pulling a train. The lighter locomotive, compared with the freight train, was stopped by the energy-absorbing deformation of the equipment and the deflecting lead unit of No. 88. The mass of the freight train shoved the helper locomotive eastward a considerable distance which accounts for the reduced damage.

Other Safety-Related Aspects

The dispatcher's telephone network is a vital part of his control system. It remains "on" at all times so that the dispatcher can be contacted by an audible page by anyone having access to the telephone. A noisy telephone system can be irritating and distracting. To aid him in the performance of his duties, the train dispatcher should be provided with a quiet, dependable communications network which will not be a distraction or produce fatigue by causing him to strain to hear the communication.

7/ Railroad Accident Report--"Head-on Collision of Louisville and Nashville Railroad Local Freight Train and Yard Train at Florence, Alabama, September 18, 1978." (NTSB-RAR-79-2.)
Railroad Accident Report--"Rear End Collision of Two Union Pacific Freight Trains, Ramsey, Wyoming, March 29, 1979." (NTSB-RAR-79-9.)
Railroad Accident Report--"Head-on Collision Between Amtrak Train No. 82 and Seaboard Coast Line Extra 2771 South, Lakeview, North Carolina, April 2, 1980." (NTSB-RAR-80-8.)

CONCLUSIONS

Findings

1. Train No. 88 and the Brunswick Helper were being operated in compliance with the operating rules.

2. The Brunswick Helper had a proper train order and clearance to move westward on No. 2 track between the crossover at Gaithersburg and WAS Rocks.

3. Train No. 88's crew was not aware that the Brunswick Helper was being operated westbound on No. 2 track, and the Brunswick Helper's crew was not aware that train No. 88 was moving eastward between Rocks and Gaithersburg on No. 2 track.

4. The Baltimore Terminal Dispatcher failed to ascertain the location of train No. 88 when he authorized the Brunswick Helper to return to Rocks on No. 2 track.

5. The number and complexity of activities in which the Baltimore Terminal dispatcher was engaged before the train order was issued to the Brunswick Helper probably caused him to overlook train No. 88.

6. B&O operating procedures did not require the Baltimore Terminal dispatcher's coworkers to remind the dispatcher of, or question him about, the status of trains such as No. 88.

7. The operating procedure, which allowed trains to pass Rocks without the OML dispatcher giving the passing time to the Baltimore Terminal dispatcher and the next tower ahead of the train, was inadequate.

8. Had. No. 88's passage at Rocks been communicated between the two dispatchers or between the Baltimore Terminal dispatcher and the operator at QN Tower, the collision probably would have been avoided.

9. If the radio speaker on the Brunswick Helper's unit 7603 had been operable, the accident probably would have been avoided.

10. The environmental conditions in which the two dispatchers were working were distracting and could be detrimental to the performance of their duties.

11. The crushing of the locomotive operating compartment of the Brunswick Helper's unit 7603 resulted in an unsurvivable environment.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the train dispatcher's oversight in authorizing the Brunswick Helper to operate westward on the No. 2 eastward main track between Gaithersburg and Rocks, while opposing train No. 88 was en route eastward on the same track. Contributing to the accident was an inadequate Baltimore & Ohio Railroad Company operating procedure which did not provide means for the train dispatcher and the tower operator to positively verify the location of all trains between Rocks and QN Tower, and did not provide for a backup system that would require coworkers to verify train locations when train orders are being used.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations to:

--The Baltimore & Ohio Railroad Company:

> Establish a train reporting procedure at Rocks and similar locations, that will enable each train dispatcher and the tower operator, in advance and to the rear of the train, to have a record of the times trains pass the reporting point. (Class II, Priority Action) (R-81-70)
>
> Evaluate the workloads carried by the Old Main Line and the Baltimore Terminal dispatchers to determine if they are manageable. If either is not, adjust the workloads so that each dispatcher has a manageable assignment. (Class II, Priority Action) (R-81-71)
>
> Redesign the Baltimore train dispatcher's office to provide facilities based on good human engineering principles and to eliminate the current distractions and uncomfortable environment. (Class II, Priority Action) (R-81-72)
>
> Upgrade the radio system to eliminate the marginal coverage area between Barnesville and Gaithersburg. (Class II, Priority Action) (R-81-73)

The Safety Board believes that an operable radio speaker on Brunswick Helper unit 7303 would have provided information to the enginecrew that might have led to action having been taken to have avoided the accident. Therefore, NTSB Safety Recommendations R-79-73, issued on November 1, 1979, to the Federal Railroad Administration and which is now classified by the National Transportation Safety Board as still open, is reiterated to the Federal Railroad Administration:

> "Establish regulations that would require all trains operating on main track to be equipped with an operable radio."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

ELWOOD T. DRIVER, Vice Chairman, did not participate.

May 27, 1981

APPENDIXES

APPENDIX A

INVESTIGATION

The National Transportation Safety Board was notified of the accident about 10:30 a.m. by the Baltimore & Ohio Railroad Company through the National Response Center at Washington, D. C. It was declared a major accident and an Investigator-in-Charge and a Field Investigator from the Safety Board's Washington Headquarters were dispatched to the scene.

APPENDIX B

TRAIN ORDER NO. 107

TRAIN ORDER NO. 107 February 9, 1981

TO: C&E EXTRA 7603 At: QN Tower
West Gaithersburg via QN Tower

EXTRA 7603 WEST HAS RIGHT OVER OPPOSING TRAINS ON NUMBER 2 TRACK GAITHERSBURG TO WAS ROCKS.

VGR

OK By Eng. R.H. Rouzee
2/9/81 At 9:43 a.m.
JRC

Retyped from
Certified True Copy

APPENDIX C

EXCERPTS FROM OPERATING RULES

Block—(Automatic Block Signal System)—The length of track between two automatic signals in the same direction, the use of which by trains is governed by an automatic block or interlocking signal.

Block—(Manual Block System)—The length of track between the points specified on Clearance Form A, Part 2.

Clear Block—A term used in connection with Manual Block System Rules indicating the block is clear of trains authorized to move in the same direction as the train addressed.

Occupied Block—A term used in connection with Manual Block System Rules indicating there are one or more trains (as listed on Clearance Form A, Part 2) occupying or authorized to occupy the block and move in the same direction as the train addressed.

MANUAL BLOCK SYSTEM RULES

300. Manual Block System Rules will be in effect in territory specified in special instructions or when trains are moved against the current of traffic.

Exception:
Manual Block System Rules will not be in effect when movements are made as prescribed by Rules 89, 93, 235 D-H, 515-A, D-515-B, D-515-C or emergency or switching movements as provided in Rules D-151 and 605-A.

301. The term "clear block" or "occupied block" as used in these rules refer only to trains moving in the same direction. Opposing trains will be governed by timetable schedule or by train order with respect to each other.

302. The Train Dispatcher will specify the condition of the block "clear" or "occupied". The block must be specified between train order offices or specific locations such as crossovers, junctions, ends of passing sidings, ends of two or more tracks, absolute signals, or controlled points.

304. The train order signal will not be used to indicate the condition of the block. The condition of the block must be given by Clearance Form A, Part 2 at open train order offices or orally at intermediate points.

305. Clearance Form A, Part 2 will be issued at each open train order office. The condition of the block must be shown "clear" or "occupied" between the points shown on Clearance Form A, Part 2 but not beyond the next open train order office. Trains must approach and pass open train order offices at "Stop Short of Train Ahead" speed and be governed by the condition of block shown on Clearance Form A.

Exception:
If the next open office is due to close before a train arrives, the condition of the block may be given beyond the office due to close. If the train arrives before the office is closed, the Operator must deliver a Clearance Form A showing the condition of the block. In such case, the condition of the block received at the previous open office would not apply beyond the office due to close.

If a train order office in the block opens after a train has entered the block and the block was given beyond the office that opened, the Operator must deliver a Clearance Form A showing the condition of the block. In such case, the condition of the block received at the previous open office would not apply beyond the office that opened.

306. When the condition of the block is to be received at a closed train order office or at an intermediate point, the condition of the block will be given orally to the Conductor or Engineer.

307. When the block is clear, train will proceed at the speed designated by special instructions or train order. When the block is occupied, the Clearance Form A must identify the train or trains ahead. Trains receiving an occupied block must proceed within that block prepared to stop short of train ahead.

308. When a train operating on a clear block is passed by a train moving in the same direction, or reverses movement and follows a train, movement from that point must be made prepared to stop short of train ahead.

309. When a train is moving on an occupied block and the train(s) ahead have cleared the block, the Train Dispatcher will notify the Conductor and Engineer, if communication is available, that the block is clear.

310. When a train moving on an occupied block passes all trains listed on the Clearance Form A, the condition of the block will be clear to the point listed on the Clearance Form A.

317. To admit a train to a block, the Train Dispatcher must examine the train sheet and if block is clear of preceding trains, he may specify a clear block. If there are preceding trains, the Train Dispatcher must specify an occupied block, identifying trains ahead.

After a train has entered a block, another train must not be authorized to enter that block and move in the same direction ahead of the first named train until the first named train has been stopped and the Engineer informed of the train movement to be made.

317-A. The Train Dispatcher will record the condition of the block in the Train Order Book.

326. When a train reports clear of the main track, it must not again foul the main track without permission of the Train Dispatcher. A train must not reverse direction without permission of the Train Dispatcher. The Train Dispatcher must have control of following movements or movement must be protected by Flagman before permission is given to reverse direction.

327. A train must not foul a main track or cross over from one main track to another without permission of the Train Dispatcher.

235 D-R. Providing for a Movement Against The Current of Traffic

Example (1) of Train Order

No 1 Eng 4219 (Train) has right over opposing trains

on ______ (Track) ______ *C* (Specific Location) to

F (Specific Location)

Explanation:

The designated train must use the track specified between the points named and has right over opposing trains on that track between those points. Opposing trains must not leave the point last named or any intermediate point until the designated train arrives.

This order may be modified as follows:

Example (2) of Train Order

After *No 4 Eng 8254* (Train) arrives at *C* (Specific Location)

No 1 Eng 8260 (Train) has right over opposing trains on

______ (Track) ______ *C* (Specific Location) to *F* (Specific Location)

Explanation:

The train to be moved against the current of traffic must not leave the first named point until the arrival of the first named train.

. . . .

The order must name the specific point to which the train is authorized to run.

A train must not be moved against the current of traffic until the track on which it is to run has been cleared, and is maintained clear of all opposing train movements and track cars within the designated limits, until the diverted train or trains have arrived.

Following movements may be permitted complying with Rule 307.

Where Rule 93 is in effect and Rules 501-D-515-C are not in effect, a copy of the order must be given to the Yardmaster on duty or to all trains within yard limits. Such trains must not occupy the track on which the designated train or trains are to run until the diverted train or trains have arrived.

RULES GOVERNING THE MOVEMENT OF TRAINS IN THE SAME DIRECTION BY BLOCK SIGNALS

D-251. On portions of the railroad and on tracks designated in special instructions, trains will run with the current of traffic, being governed by block signals, the indications of which will supersede timetable superiority.

When trains are moved against the current of traffic, Manual Block System Rules are in effect except as provided in Rules 89, 93, 235 D-H, 515-A, 515-B, 515-C or emergency or switching movements as provided in Rules D-151 and 605-A.

D-252. Trains must not enter, cross over or in any way foul a main track through hand-operated or spring switches when operated by hand, until Conductor or Engineer has secured permission of the Train Dispatcher. Neither switches nor derails may be hand-operated until permission has been secured. Such permission does not relieve employees of waiting for signal protection as prescribed by Rule 513.

At locations where Switchtenders or Operators handle the switches, train may accept hand signal to cross over or enter the main track. This will not relieve Switchtenders or Operators of securing permission of the Train Dispatcher for such movement, nor will such employees be relieved of waiting for signal protection in accordance with Rule 513 except when controlled absolute signals protecting main track movements over the switches involved have displayed STOP aspect at least five (5) minutes before switch or switches are operated.

D-254. Where these rules are in effect, Rules 501-515-C are also in effect.

RULES GOVERNING OPPOSING AND FOLLOWING MOVEMENT OF TRAINS BY BLOCK SIGNALS

261. On portions of the railroad and on tracks designated in special instructions, trains will be governed by block signals, the indications of which will supersede timetable superiority of trains for both opposing and following movements on the same track.

262. Except as provided in Rule 271 or 274, a train must not reverse direction within a block without the authority of the Train Dispatcher who must first protect the movement. Movement must be made at restricted speed to the next signal. Flag protection will not be required.

264. Where these rules are in effect, Rules 501-515 are also in effect.

TRAFFIC CONTROL SYSTEM (TCS) RULES

265. Traffic Control System Rules will be used only in territory specified in special instructions.

Where TCS Rules are in effect, Rules 261-264 and Rules 501-515 are also in effect.

267. Trains must not enter or foul the main track or other signalled track where these rules are in effect, nor cross over from one such track to another, except as governed by signal indication or by permission of the Train Dispatcher obtained by the Conductor or Engineer.

When trains clear on any track not provided with an absolute block signal to govern the movement from such track, the Conductor or Engineer must report clear to the Train Dispatcher.

267-A. At non-electrically-locked hand-operated switches where the speed of trains is not permanently limited to twenty (20) MPH, trains must not clear or enter the main track unless the track is so designated in special instructions. Trains using tracks on which they are not permitted to clear must leave part of train on signalled track or leave switch open until work is completed.

267-B. Permission of the Train Dispatcher must be secured to hand-operate a switch to enter main track or other signalled track. This does not relieve employee of compliance with Rule 513 unless absolute block signal is provided to govern movement.

271. Trains may occupy specific absolute block sections to work in both directions without flag protection when authorized by the Train Dispatcher. Conductor must make record of time, track and work limits, advising the Engineer accordingly.

Conductor must report clear before time limit expires unless extension of time limit has been secured. Train which has been reported clear must not again occupy the work limits without securing new authorization.

The authorization to work does not relieve crew of compliance with block signal indications.

When more than one train is authorized to work in the same limits, the authorization must include the requirement for such trains to protect against each other, Engineers advised and movements made at a speed that will permit stopping within one-half the range of vision regardless of signal aspect displayed.

271-A. When a reverse movement is made under the provisions of Rule 262, 271 or 274, and rear of movement is standing between the absolute block signals governing movement over power-operated switches, such switches must be protected in accordance with Rule 509-A(3).

272. When employee call light on the instrument house is illuminated, any employee observing it, except those on moving trains, must immediately communicate with the Train Dispatcher or Operator.

274. Where designated by special instructions that this rule is in effect, trains may move or work in both directions within an absolute block section without flag protection. Movement must be made at a speed that will permit compliance with signal aspect displayed.

When more than one train is authorized to occupy the same absolute block section, the authorization must include the requirement for such trains to protect against each other, Engineers advised and the movements made at a speed that will permit stopping within one-half the range of vision.

APPENDIX D

CREWMEMBER, TRAIN DISPATCHERS, AND OPERATOR INFORMATION

Russell Harrison Rouzee, Engineer Extra 7603 West

Mr. Rouzee, 43, was employed by the B&O Railroad Company on June 3, 1950, as a fireman. He was promoted to his current standing as an engineer on December 24, 1967. He attended his last operating rule class on February 4, 1980, and he passed his last medical examination on August 18, 1980.

Donald Elwood Greenfield, Brakeman Extra 7603 West

Mr. Greenfield, 35, was employed by the B&O Railroad Company on February 22, 1974, as a brakeman. He attended his last operating rules class on February 5, 1980, and he passed his last medical examination on June 21, 1977.

Raymond D. Dow, Engineer Extra 3773 East (No. 88)

Mr. Dow, 56, was employed by the B&O Railroad Company on May 10, 1950, as a fireman. He was promoted to engineer on December 24, 1967. He attended his last operating rules examination on February 11, 1980, and he passed his last medical examination on November 13, 1978.

Roy Leon Poole, Fireman Extra 3773 East

Mr. Poole, 38, was employed by the B&O Railroad Company in April 1977 as a brakeman. He transferred to engine service on June 10, 1977 as a fireman. He was promoted to engineer on April 14, 1980. He attended his last operating rules class on February 11, 1980, and he passed his last medical examination in June 1977.

Calvin M. Hooker, Conductor Extra 3773 East

Mr. Hooker, 59, was employed by the B&O Railroad Company in September 1945 as a laborer at a grain elevator. He transferred to train service on August 25, 1972 as a brakeman. He was promoted to conductor on September 16, 1974. He attended his last operating rules class on February 5, 1980 and he passed his last medical examination on March 7, 1979.

James E. Wilson, Flagman Extra 3773 East

Mr. Wilson, 29, was employed by the B&O Railroad Company on June 6, 1972 as a brakeman. He was promoted to flagman on May 22, 1973. He attended his last operating rules examination on February 6, 1980, and he passed his last medical examination on November 11, 1979.

Larry V. Sauerwein, Brakeman, Extra 3773 East

Mr. Sauerwein, 26, was employed by the B&O Railroad Company on June 24, 1973, as a brakeman. He attended his last operating rules class on February 22, 1980, and he passed his last medical examination on May 30, 1978.

Vernon Glenn Ray, Sr. Train Dispatcher Baltimore Terminal

Mr. Ray, 36, was employed by the B&O Railroad Company on November 20, 1966, as an operator. He was promoted to extra train dispatcher on December 27, 1970, and was appointed to a regular position during 1976. He attended his last operating rules examination in 1980.

Homer Emanuel Bair, Train Dispatcher Old Main Line

Mr. Bair, 36, was employed by the B&O Railroad Company on January 15, 1964, as an Operator Trainee. He was promoted to the position of operator on April 8, 1964, and he was promoted to extra train dispatcher in March of 1970. He was appointed as a regular dispatcher on January 28, 1976. He is current on the operating rules examinations.

James Byran Carpenter, Operator QN Tower

Mr. Carpenter, 29, was employed by the B&O Railroad Company on May 27, 1970, as an operator. He has worked as an agent and regularly as an operator at JD Tower, Hyattsville, Maryland before he became assigned regularly to the 7:00 a.m. to 3:00 p.m. shift at QN Tower in January 1980. He is current on both the operating rules and medical requirements.

APPENDIX E

B&O SPECIAL INSTRUCTIONS

Baltimore, Md.
March 13, 1981

TERMINAL DISPATCHERS
TCS DISPATCHERS
OPERATORS WB TOWER
OPERATORS QN TOWER

SUBJECT: Procedure when providing for movement against current of traffic westward on No. 2 track between Georgetown Junction and Rocks on the Metropolitan Subdivision.

In adddition to complying with existing Rules the following procedure must be complied with in sequencial order:

1. When the Terminal Train Dispatcher requests the TCS Dispatcher to hold east at Rocks, the TCS Dispatcher must apply blocking before responding. In addition to blocking the eastward absolute signals on No. 1 and No. 2 tracks at Rocks and eastward absolute signal on No. 2 track at High Rock, the TCS Dispatcher must also instruct the Operator at WB Tower to apply blocking to eastward absolute signals governing movements to No. 1 track at East Brunswick.

2. When all blocking is in place the TCS Dispatcher will then respond, "Blocking East at Rocks", giving the last eastward train to the Metropolitan Subdivision and the time it passed Rocks.

3. The Terminal Dispatcher must examine his train sheet to be certain that the section of track on which the train is to run against the current of traffic has been CLEARED of all opposing train movements and/or track car movements.

4. The Terminal Train Dispatcher will then include the "TCS Dispatcher", in the address of the 235 D-R train order example (1) or (2).

5. The TCS Train Dispatcher must copy the 235 D-R train order on the prescribed train order Form CDT-40. These instructions apply even if an Operator is on duty at Rocks.

6. The Terminal Train Dispatcher's territory begins and ends at Rocks therfore the TCS Train Dispatcher must "OS" both eastward and westward trains by Rocks to the Terminal Train Dispatcher.

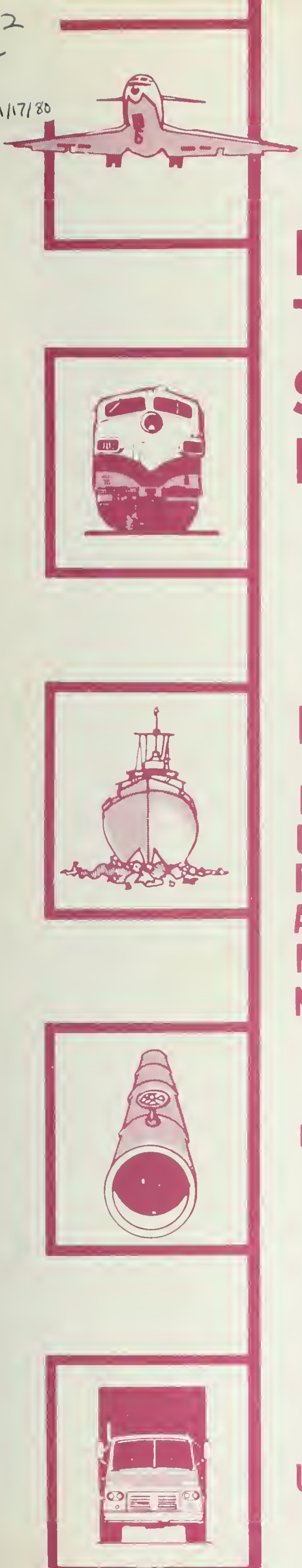
Instructions to the Operators at QN Tower:

The Operators at QN Tower before copying a 235 D-R train order from the Terminal Train Dispatcher for a westward movement on No. 2 track between Georgetown Junction and Rocks must:

1. Give the Dispatcher the last train east and time by QN Tower.
2. Must remind the Train Dispatcher of any train(s) reported east by WB Tower that has not yet passed QN Tower.

E. Q. Snyder
Superintendent of Operations

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-341-828/34



NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

**REAR-END COLLISION OF
UNION PACIFIC RAILROAD COMPANY
FREIGHT TRAINS EXTRA 3119 WEST
AND EXTRA 8044 WEST
NEAR KELSO, CALIFORNIA
NOVEMBER 17, 1980**

NTSB-RAR-81-7

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-81-7	2. Government Accession No. PB82-109331	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report—Rear End Collision of Union Pacific Railroad Company Freight Trains Extra 3119 West and Extra 8044 West, Near Kelso, California, November 17, 1980		5. Report Date August 18, 1981
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3168A
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16. Abstract
About 2:29 p.m., P.s.t., on November 17, 1980, Union Pacific Railroad Company (UP) work train Extra 3119 West ran out of control while descending a long 2.20-percent grade, overtook, and struck the rear of UP freight train Extra 8044 West (2-VAN-16) on the UP's single main track near Kelso, California. Three train crewmembers were killed and one crewmember was injured. The locomotive unit of Extra 3119 West, the caboose of Extra 8044 West, and 23 freight cars were destroyed. Total damage was estimated at $1,200,000.

The National Transportation Safety Board determines that the probable cause of this accident was the dispatcher's permitting Extra 3119 West to leave Cima with inadequate braking capability, the inadvertent release of the train's brakes after they were placed in emergency from the caboose, and the UP's inadequate rules and instructions for the management of trains on mountain grades that resulted in the engineer's inability to control the speed of the train. Contributing to the accident were the failure to properly inspect and test Extra 3119 West at Las Vegas, the inadequate maintenance of braking equipment on tie cars used in company service, and the practice of underestimating the weight of loaded tie cars. Contributing to the severity of the accident were the lack of effective direction by the dispatcher and assistant chief train dispatcher and the absence of emergency procedures for train operations on Cima Hill.

17. Key Words Rear-end collision, accelerating, single-main track, fatal, diesel-electric, freight train, brake system, CTC, brake test, dispatching, emergency procedures, train braking, train handling, train inspection, cycle braking, dynamic braking, air brake rules, brakepipe flow indicator, pressure maintaining, descending grade, Federal Power Brake Regulations, enforce regulations.		18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*	
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CONTENT

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: August 18, 1981

REAR-END COLLISION OF UNION PACIFIC RAILROAD COMPANY FREIGHT TRAINS EXTRA 3119 WEST AND EXTRA 8044 WEST (2-VAN-16) NEAR KELSO, CALIFORNIA NOVEMBER 17, 1980

SYNOPSIS

About 2:29 p.m., P.s.t., on November 17, 1980, Union Pacific Railroad Company (UP) work train Extra 3119 West ran out of control while descending a long 2.20-percent grade, overtook, and struck the rear of UP freight train Extra 8044 West (2 VAN-16) on the UP's single main track near Kelso, California. Three train crewmembers were killed and one crewmember was injured. The locomotive unit of Extra 3119 West, the caboose of Extra 8044 West, and 23 freight cars were destroyed. Total damage was estimated at $1,200,000.

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INVESTIGATION

The Trip From Las Vegas to Cima

At 10:00 a.m., on November 17, 1980, Union Pacific Railroad Company (UP) westbound work train Extra 3119 West, consisting of locomotive unit 3119, 20 specially-fitted bulkhead flatcars loaded with crossties, and a caboose, departed Las Vegas, Nevada, for Yermo, California. (See figure 1.) The clearance form issued to the crew authorized a maximum speed of 50 mph for the train. Extra 3119 West was followed from Las Vegas at 10:20 a.m., by a 73-car loaded grain train, Extra 3135 West (SGT-722), and at 12:05 p.m., by Extra 8044 West (2-VAN-16), a through freight train consisting of 49 loaded automobile and piggyback flatcars and a caboose. The maximum authorized speeds for the grain train and the VAN train were 50 and 70 mph, respectively.

STATION	MILEPOST
Las Vegas	334.3
5.2	
Bracken	329.1
6.6	
Arden	322.5
13.2	
Erie	309.3
8.0	
Jean	301.3
13.7	
Calada	278.6
20.2	
Ivanpah	267.4
13.4	
Cima	254.0
3.6	
Chase	250.4
3.1	
Elora	247.3
4.0	
Dawes	243.3
4.0	
Hayden	239.3
3.9	
Kelso	235.4
4.8	
Point of Collision	230.6
53.1	
Manix	177.5
14.4	
Yermo	163.1

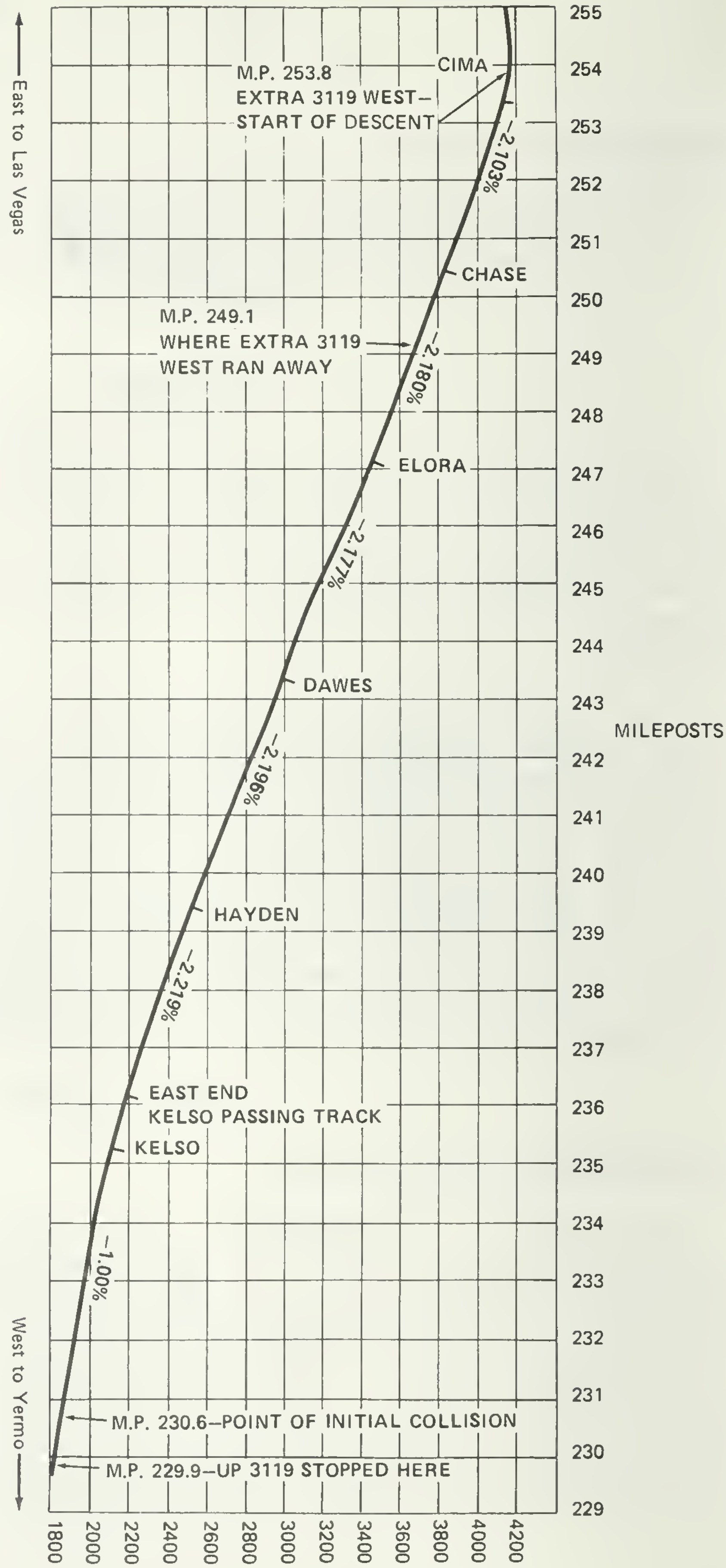

Figure 1.--Profile of Union Pacific Railroad
from Cima to Kelso, California, and the point of collision.

About 3 1/2 miles west of Las Vegas, Extra 3119 West stopped briefly while a rail detector car cleared into a passing track at Bracken, Nevada. The train was decelerated quickly from 25 mph on a 0.80-percent ascending grade, but it is not known whether the engineer resorted to braking action to stop the train or to hold it on the grade. From Bracken to Erie, Nevada, Extra 3119 West was on a continuous ascending grade for 20 miles, most of which was at the rate of 1.00 percent. 1/ Speed was maintained at 20 to 22 mph on the grade except at Arden, Nevada, where several miles of lesser gradient permitted the train to briefly accelerate to slightly higher speeds. About this time, the dispatcher at Salt Lake City, Utah, radioed the engineer of Extra 3119 West to find out if his train was moving fast enough to avoid delaying Extra 3135 West. The dispatcher was satisfied with the train's speed and allowed it to continue to run ahead of Extra 3135 West.

After cresting the grade at Erie summit, Extra 3119 West started down a 14-mile section of railroad with varying gradient up to 1.00 percent, all but about 2 miles of which was descending westbound. In the first 3 miles, Extra 3119 West accelerated from 22 to 57 mph on a downgrade of up to 0.68 percent and then slowed to about 49 mph on a half mile of level grade. Thereafter, speed varied between 41 and 57 mph with the fluctuations generally corresponding to changes in the gradient. According to the conductor and rear brakeman, the train brakes were applied after the train passed Erie. During the descent from Erie, the engineer informed the dispatcher that the locomotive had no effective dynamic braking 2/ and that when descending the 17-mile, 2.20-percent grade between Cima and Kelso, California, he would have to use retainers, 3/ restrict speed to 15 mph, and stop the train on the grade at Dawes to cool the wheels--all of which were actions required by timetable special rule 1042(RC). (See appendix C.) The dispatcher acknowledged the engineer's report without comment and he encoded the Traffic Control machine to route Extra 3119 West into the north passing track at Cima, 79 miles west of Las Vegas.

Over the 27 miles of generally 1.00-percent ascending grade to Cima summit, Extra 3119 West maintained a speed of 22 mph except in three short sections of lesser gradient where the speed increased briefly. Extra 3119 West arrived at Cima at 1:29 p.m., pulled into the north passing track, and stopped more or less balanced on the apex of the grade. After the train stopped, the conductor and flagman walked forward from the caboose, setting up the retainers in the high-pressure position. About halfway to the head end, they met the head brakeman who had been setting up the retainers on the forward part of the train. The conductor and flagman then returned to the caboose and the head brakeman worked his way back to the locomotive. The conductor and flagman stated that they observed no defects and heard no air leaks in the rear portion of the

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1/ A 1.00-percent grade denotes a vertical rise or fall of one foot in each 100 feet of horizontal distance.

2/ Dynamic braking results from reversing the field of the locomotive's traction motors thereby changing them into generators and thus causing retardation of the locomotive wheels. This form of braking is independent of the locomotive and train air brake systems. Many, but not all, diesel-electric locomotive units are equipped with this feature.

3/ Freight cars are equipped with retainers (air brake retaining valves) which can be set to retain air pressure in the brake cylinders as a means of controlling speed by continuous braking effort while the engineer releases the automatic air brake in order to restore pressure in the trainline, or brakepipe. Use of retainers permits frequent applications and releases of the train brakes on heavy grades without seriously depleting brakepipe air pressure or braking capability. The technique is commonly referred to as cycle braking.

train. According to the conductor, the head brakeman did not report finding any defect in the forward part of the train. Shortly afterwards, the engineer moved the train ahead to a point about 1,100 feet east of the westbound home signal for the north passing track. According to the conductor, the gauge in the caboose indicated 90 pounds of brakepipe pressure and zero pounds of brake cylinder pressure.

Extra 3135 West (grain train SGT-722) arrived at Cima at about 1:35 p.m. and occupied the south passing track. Because this train weighed more than 132 tons per operative brake, the crew proceeded to set up their train's retainers as required by special rule 1042(RC). (See appendix C.) At 1:46 p.m., Extra 8044 West (2-VAN-16) arrived at Cima, reduced speed to about 13 mph as it passed over the summit, and began descending the grade to Kelso. After the VAN train cleared Cima, the dispatcher asked the engineer of Extra 3119 West if he was ready to leave. When the engineer replied affirmatively, the dispatcher encoded the traffic control machine to route the train from the north passing track to the main track. After the VAN train cleared intermediate signal 2523 4/, the passing track switch automatically reversed and the home signal changed from a red "Stop" aspect to a yellow "Approach" aspect, permitting Extra 3119 West to "Proceed prepared to stop before any part of train or engine passes the next signal. . . ." Extra 3119 West cleared the turnout to the main track at 1:59 p.m., and the dispatcher then encoded his machine to reverse the south passing track turnout. When Extra 3119 West cleared signal 2523, Extra 3135 West moved out of the south passing track on an "Approach" signal aspect.

The Accident

Leaving the north passing track at Cima, Extra 3119 West accelerated to 14 mph in 0.3 mile, slightly more than the distance from its starting point to the turnout, and by the time the caboose entered the main track, speed had reached about 17 mph. The engineer responded by initiating braking action which reduced the train's speed to about 13 mph, but almost immediately Extra 3119 West began to reaccelerate. In an apparent attempt to stabilize speed at 15 mph, the engineer made another brake application at 16 mph, but it was insufficient to prevent reacceleration above 15 mph. According to the conductor and flagman, the brakes had applied on the caboose and at no time were the brakes released.

At 2:09 p.m., Extra 3119 West reached milepost 250.6, midway between the passing track turnouts at Chase and 3 miles west of Cima. By this time, the engineer had made two additional brake applications and each time the speed had reduced to the desired 15 mph only to pick up again within one- or two-tenths of a mile. After making the last brake application, the engineer informed the dispatcher that he was having trouble. The engineer of the VAN train recalled him stating, "I keep setting air and it won't slow down." Also at 2:09, the rear of the VAN train passed the west end of the passing track at Elora, running in full dynamic braking with train brakes applied and speed stabilized at about 25 mph. At this time, the VAN train was 3.9 miles ahead of Extra 3119 West. At the same time, Extra 3135 West cleared the passing track at Cima moving at about 20 mph. The head end was about 2.9 miles behind Extra 3119 West which was fully visible to the engineer of Extra 3135 West. He noticed that Extra 3119 West was smoking heavily as it passed Chase, and he remarked to the head brakeman that this seemed unusual considering the short distance the train had traveled.

4/ Signal 2523 was located 6,705 feet west of the home signal at the west end of the north passing track at Cima.

The engineer of Extra 3119 West was never again able to reduce the speed of the train. At 2:13 p.m., it was accelerating at the rate of 1.6 mph per minute and had attained a speed of 19.5 mph. At this time, the VAN train had reached the east turnout of the Dawes passing track, maintaining 25 mph, and was now separated from Extra 3119 West by about 4.8 miles. As Extra 3135 West approached the signal at the east end of Chase, the engineer observed the signal aspect change from red to yellow and then to green, indicating that Extra 3119 West had rapidly passed both the west end of Chase and the intermediate signal west of Chase. About this time, the engineer of Extra 3135 West heard the engineer of Extra 3119 West state that he had 30 pounds of engine brakes, indicating that he had made a substantial application of the independent brake. About this time, also, the conductor of Extra 3119 West used the caboose valve to apply the train's brakes in emergency. He did not use his radio to inform the engineer that he had done this, but hearing the brakepipe exhaust he assumed the brakes had applied in emergency throughout the train. Almost immediately after making the emergency application, the conductor and flagman went to the forward platform and made a futile effort to uncouple the caboose.

At 2:15 p.m., the engineer of Extra 3119 West called the dispatcher and informed him that he had made a full service application of the brakes, was traveling at 25 mph, and was still accelerating. The dispatcher asked if this meant that he was not going to stop at Dawes to cool the wheels, and the engineer replied that he did not think he would be able to stop. The conversation was heard by the engineer of the VAN train and by the conductor of an eastbound train in the passing track at Kelso. The dispatcher did not comment, nor did he take any action.

By 2:15 p.m., Extra 3119 West was at milepost 248.8 and was approaching the east turnout of the Elora passing track. A minute earlier, the train's speed had stabilized at 20 mph for about three-tenths of a mile, followed by a sudden and dramatic reacceleration at an average rate of 5 mph per minute. Extra 3119 West was running out of control on the downgrade with very little effective retardation. It was, however, about 5 miles behind the VAN train. Recognizing what was happening to Extra 3119 West, the VAN engineer began to accelerate his train by first releasing the train brakes and then by gradually throttling down the dynamic braking to idle, changing to power position, and reopening the throttle. The engineer had asked for and was granted by the dispatcher authority to exceed the 25-mph speed limit for his train.

Extra 3119 West reached milepost 247.8, at 2:17 p.m., making 39 mph just as the VAN train was clearing the west turnout of Dawes passing track at milepost 242.7. At 2:21, Extra 3119 West was at milepost 244.4 between the turnouts at Dawes moving at 62.5 mph, and the VAN train had passed the west end of Hayden passing track at milepost 238.8. The VAN train was now being operated in full throttle and had attained a speed of about 65 mph. The 5-mile gap between the trains was being maintained and the VAN train could accelerate to about 75 mph before the locomotive's overspeed feature became operative. However, Extra 3119 West continued to accelerate at a phenomenal rate. When it reached milepost 241.2 shortly after 2:24 p.m., it was moving at 80 mph, the limit of the locomotive's speed indicator. As Extra 3119 West had moved out of control down the mountain, the engineer repeatedly broadcast the indicated speed of the train, even after actual speed had passed 80 mph. Because the engineer kept broadcasting his speed as being 80 mph, the engineer of the VAN train believed that Extra 3119 West had finally reached maximum velocity and that he still had a chance to outrun it west of Kelso where the downgrade was only 1.00 percent.

When the VAN train reached the east end of Kelso, the locomotive's overspeed feature became operative and caused an immediate loss of power. Although the engineer succeeded in forestalling a penalty brake application, the train had decelerated to about 68 mph before the engineer could restore full power operation and begin reacceleration. In the interim, Extra 3119 West continued to pick up speed at the rate of 6 to 8 mph per minute and it passed through Kelso only a minute behind the rear of the VAN train. As Extra 3119 West passed through Kelso, the locomotive whistle was sounded continuously. The engineer was observed facing forward seated at his post holding the radio microphone in front of his face. He continued to inform the VAN engineer of the rapidly closing distance between the trains. When Extra 3119 West passed the hotbox detector at milepost 233.9, it was moving at 112 mph.

The VAN train again reached the 75-mph mark about 2 1/2 miles west of Kelso. At this point, the head brakeman succeeded in preventing a second operation of the overspeed feature by interrupting the operation of the speed recorder stylus. However, the only remaining hope of avoiding a collision was that Extra 3119 West would derail in the 2°03' curve at milepost 231. Although Extra 3119 West was moving nearly twice the maximum speed for the curve, it did not derail. At 2:29 p.m., Extra 3119 West struck the caboose of the VAN train on tangent track at milepost 230.6. The VAN train and Extra 3119 West were moving at 80 to 85 mph and about 118 mph, respectively, when the collision occurred.

Collision and Derailment

The accident probably consisted of four separate episodes of collision and derailment. The first occurred when Extra 3119 West struck the VAN caboose causing it to separate from the car ahead, derail, and slide down the south embankment on its side. The locomotive then struck, one at a time, the three rear cars of the VAN train which were enclosed tri-level auto rack cars. The first two cars, as with the caboose, did not offer substantial resistance to Extra 3119 West. They, too, separated from the train, turned over to the left, and slid down the south embankment. Although the first three collisions probably heavily damaged the forward superstructure of the locomotive of Extra 3119 West, they did not cause it to derail.

Separation of the caboose from the VAN train had caused the train to go into emergency braking and when Extra 3119 West struck the third rack car, the car overrode the locomotive, destroyed the remaining superstructure, and caused the locomotive to overturn the north rail. The near-instantaneous derailment of the rest of the train followed immediately. The forward 14 or 15 cars were hurtled from the grade over the north embankment with their loads of crossties ejected into the desert at a 90-degree angle to the track. (See figure 2.) The rearmost cars also derailed to the north, but less violently, and the two rear cars and caboose remained coupled. These three cars stopped in an upright position on the track structure. The forward 46 cars and the locomotive units of Extra 8044 West stopped normally as a result of the emergency brake application and did not derail.

The general derailment area began about 500 feet west of the initial collision location and extended for 700 feet farther west. The locomotive unit of Extra 3119 West stayed on the track structure and came to a stop about 2,100 feet west of the original point of collision and 1,900 feet west of the caboose of Extra 3119 West.

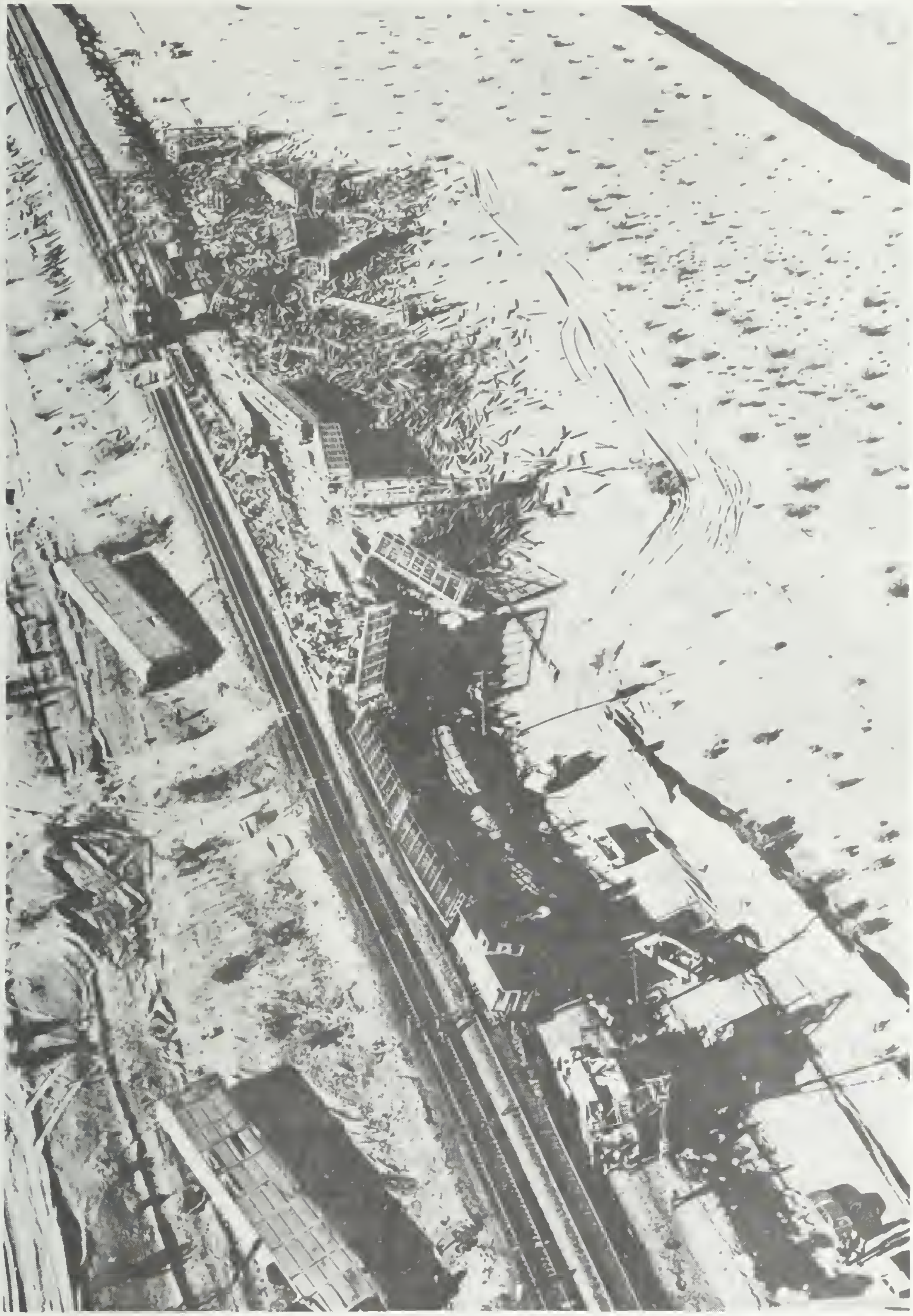

Figure 2.--Aerial view of accident location viewed to the west. The caboose and cars of Extra 3119 West are to the right of the tracks. Derailed auto rack cars of the VAN train are to the left. The left-hand track was constructed after the accident for train operations during wreckage clearing operations.

Injuries to Persons

The engineer and head brakeman were on the locomotive of Extra 3119 West when the collision occurred and both were killed. The conductor and flagman of the VAN train were in the caboose when it was struck. The conductor was killed and the flagman was critically injured.

Injuries	Extra 3119 West (2-VAN-16) Crewmembers	Extra 8044 West Crewmembers	Total
Fatal	2	1	3
Nonfatal	0	1	1
None	2	2	4

Damage to Property

The 20 tie cars and the locomotive of Extra 3119 West were destroyed, and three auto rack cars and the caboose of the VAN train were destroyed. A total of eight other cars were damaged. About 2,400 feet of track had to be replaced and a number of automobiles in the rack cars were destroyed. Damage was estimated as follows:

Train Equipment	$ 689,800
Train Lading	330,000
Track	146,600
Clearing and Salvage	33,600
Total	$1,200,000

Crewmember Information

Each of the trains involved in this accident had a conductor, engineer, and two brakemen. All were qualified under Union Pacific rules without restriction. (See appendix B.)

The crewmembers of Extra 3119 West reported for duty at Las Vegas at 8:05 a.m. on November 17, 1980, and had been on duty 6 hours 24 minutes when the accident occurred. All the crewmembers were assigned to the extra board and had last worked on November 16. During the 4 1/2 months preceding the accident, the engineer handled 27 westbound tonnage trains over the grade between Cima and Kelso. As far as could be determined, he had not encountered any previous difficulty on the grade. He was described as a very capable handler of trains by his supervisors, fellow engineers, and the conductor of Extra 3119 West. He was also known to be a stickler for compliance with rules and instructions. Prior to reporting for duty on November 17, 1980, the engineer and conductor had been off duty for 17 hours 10 minutes, and 21 hours 30 minutes, respectively. The brakemen had been off duty 20 hours 40 minutes.

The crewmembers of Extra 8044 West reported for duty at Las Vegas at 11:20 a.m., on November 17, and had been on duty 3 hours 9 minutes when the accident occurred. The crew was regularly assigned in pool freight service and all crewmembers had been off duty for at least 12 hours prior to reporting on November 17.

Postmortem toxicological screens of the blood of the engineer and head brakeman of Extra 3119 West, and the conductor of Extra 8044 West, were negative for alcohol and barbiturates.

Train Information

Extra 3119 West

Extra 3119 West originated at Las Vegas and consisted of UP diesel-electric locomotive unit 3119, 20 UP bulkhead flatcars loaded with crossties, and a UP caboose. The train's makeup was not altered en route and it had a nominal length of 1,252 feet.

UP 3119 was a General Motors Model SD40 diesel-electric locomotive unit manufactured in 1971. It was rated at 3,000 horsepower and had a working-order weight of 392,000 pounds. The unit had 6-wheel roller-bearing trucks with 40-inch wheels, clasp-type brake rigging with two 16-inch cast-iron brake shoes to each wheel. It was equipped with 26L brake equipment with a pressure-maintaining feature, extended range dynamic braking, an overspeed control set to function at 71 mph, a speed indicator and recorder, a functioning radio, and a floor-mounted pedal-type "deadman" safety device. The unit was not equipped with a brakepipe flow indicator 5/ or with an event recorder.

The caboose was an all-steel cupola type, built in 1967, and weighed about 58,700 pounds. It had 4-wheel roller-bearing trucks with 33-inch wheels and high-phosphorous cast-iron brake shoes. The caboose was equipped with electrically-powered marker lights and interior lighting as well as a radio, powered by a 12-volt battery charged by a belt-driven alternator. However, the electrical system was inoperative and the conductor had been furnished a large pack-type portable radio set. The caboose had a type AB air brake and type A-1 graduated brake valve mounted on the cupola bulkhead. Adjacent to the brake valve was a dual-needle gauge which indicated both brakepipe and brake cylinder air pressure. (See figure 3.) The caboose had end ladders which provided access from the platforms to the roof.

The bulkhead flatcars were built by UP in 1956 (see appendix H) and later modified for hauling crossties by adding steel framing on each side to prevent shifting of the ties while in transit. A total of 55 such cars carried the UP classification F-70-1. (See figure 4.) The cars were 53 feet 6 inches long over the end sills and, as modified, had an average light weight of 79,160 pounds, stenciled load limit varying from 139,000 to 141,700 pounds, and a maximum allowable gross weight of 220,000 pounds. They had cast-steel "fishbelly" type underframes, 4-wheel trucks with 33-inch wheels, 6- by 11-inch plain journals, and high-phosphorous cast-iron brake shoes. All of the tie cars in Extra 3119 West had type AB air brakes and 4-position retaining valves. They had side and end ladders the full height of the bulkhead on the brake ends of the cars.

Extra 8044 West (2-VAN-16)

Extra 8044 West (2-VAN-16) consisted of 5 UP locomotive units, 49 loaded piggyback and automobile rack cars, and a UP caboose with functioning radio. The train's trailing weight was calculated to be 3,625 tons and its nominal length was 4,750 feet. The

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5/ The brakepipe flow indicator is a differential pressure gauge designed to give the engineer an indication of the rate of air flow through the automatic brake valve to the brakepipe. The device also has an amber warning light which can be set so that it lights whenever air flow reaches a given level. UP had service-tested the device but had not adopted it as standard equipment on their locomotive units.

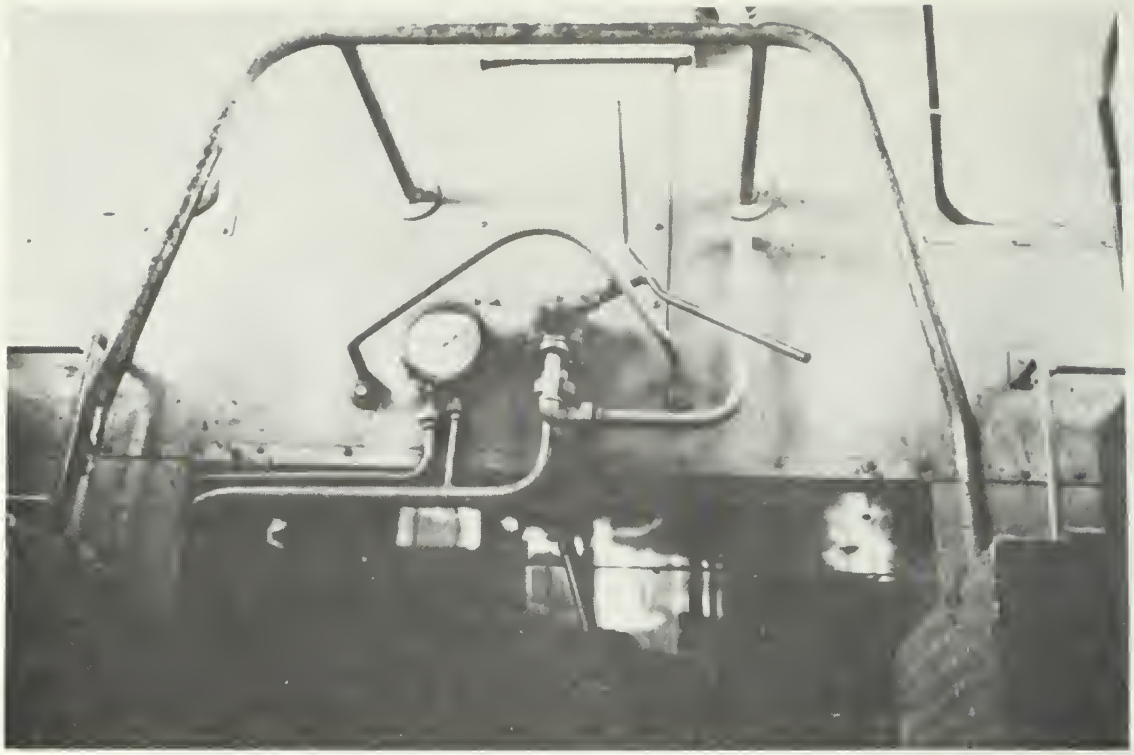

Figure 3.--Interior view of UP 25668, the caboose of Extra 3119 West, showing cupola bulkhead wall with type A-1 graduated caboose brake valve and dual-needle air pressure gauge. Viewed as found at the accident site facing forward or west.

Figure 4.--Partly-loaded UP 913000-series bulkhead flatcar modified for hauling crossties. This car was of the same type and class as the tie cars in Extra 3119 West.

lead locomotive unit was UP 6946, a General Motors model DD40X diesel-electric locomotive unit with 8-wheel trucks and a rating of 6,600 horsepower. This unit had a functioning radio, a speed indicator and recorder, and an overspeed control set to function at 76 mph. UP had removed the cutout cocks by which the overspeed control of its locomotive units could be readily rendered inoperative by the engineer. The other four locomotive units of Extra 8044 West were 3,000-horsepower SD40-2 models. Maximum dynamic braking horsepower that could be developed by the locomotive's 32 axles was 18,600 and the ratio of dynamic braking horsepower to trailing tonnage was more than 5 to 1. According to the engineer of Extra 8044 West, the air brake test performed on his train was initiated by a car inspector from the head end, as in the case of Extra 3119 West.

Makeup and Inspection of Extra 3119 West

The consignment of ties shipped from UP's timber-treatment plant at The Dalles, Oregon, arrived at Las Vegas in a through freight train at 12:55 a.m., November 17. There were 20 cars of 9-foot main track ties and 5 cars of 8-foot yard ties mixed in the head 26 cars of the train. A car loaded with beer separated the 15 forward tie cars from the 10 rear tie cars. It had been decided to run the 20 cars of 9-foot ties to the location of a tie renewal program near Yermo, Califorina, and the incoming crew was instructed to uncouple the 26-car head-end block from their train and set it over against a caboose which had been placed in the No. 5 yard track. Later, a third-shift yard crew uncoupled the block behind the beer car and placed this car and the 5 tie cars ahead of it on the wye track, after which the 10 head tie cars were coupled to the 10 cars that had been left in the No. 5 track with the caboose. Subsequently, UP 3119 was brought from the locomotive servicing facility and placed on the head end of the train. All of the air hoses in the train were coupled and the brakepipe was charged to 90 pounds, the air-brake feed valve setting on the locomotive. The car inspector who later performed the air brake test stated that he observed the caboose gauge indicating 90 pounds brakepipe pressure after the train was initially made up.

At about 7:45 a.m., 20 minutes before the reporting time of the crew of Extra 3119 West, the Las Vegas terminal superintendent was informed that Extra 3119 West contained five cars of 8-foot yard ties which could not be used in the main track and would have to be replaced by the cars that had been switched out with the beer car. The terminal superintendent at first refused to switch the train, stating that "Ties are ties." Later, he directed an 8:00 a.m. yard crew to board the 3119 and pull Extra 3119 West by him so that he could personnally determine the location of the cars that had to be switched out. This work was started about 8:20 a.m. The five cars with 8-foot ties were actually the 5th, 6th, 7th, 8th, and 10th cars from the head end and the train was again parted ahead of the rear 10 cars. Apparently due to a mixup of numbers, the 9th head car (UP 913015) was erroneously switched out instead of the 7th head car (UP 913035). All of the switching was done with air in the cars and when the train had been broken, the brakepipe had been left open and allowed to vent on the rear half of the train. After obtaining five cars of 9-foot ties from the wye track, the yard crew coupled these, with unit 3119, on the head end of the train. Air hoses were recoupled and the brakepipe was allowed to recharge. During the various switching operations at Las Vegas, the couplings within 3 blocks of tie cars were never disturbed. These blocks were the rear 10 cars, the head 5 cars, and the 6th through 9th head cars in what ultimately constituted Extra 3119 West.

Of the 20 tie cars in Extra 3119 West, one car was loaded with 586 treated 7- by 9-inch by 8-foot softwood ties intended for use in yard tracks, and the remaining 19 cars contained 10,203 treated 7- by 9-inch by 9-foot main track ties, 8,097 of which were

hardwood and the remainder softwood. As far as could be determined, the tie cars were not weighed at the treating plant, en route, or at Las Vegas, where UP had a track scale. However, the waybill for each car had a typewritten estimate of 60,000 pounds for lading. On this basis, the total estimated lading was 1,200,000 pounds, making the trailing weight of Extra 3119 West 1,421.25 tons. However, the conductor was given a form indicating the train's trailing weight was 1,495 tons. Following the accident, the UP mechanical department estimated the train's lading as weighing 2,321,317 pounds, and the train's trailing weight as being 1,981.55 tons. An expert witness engaged by UP gave the average weights for hardwood and softwood ties as being 240 and 160 pounds, respectively. On that basis, the trailing weight of Extra 3119 West would have been 2,002.74 tons.

After the switching was completed, the terminal superintendent informed the engineer that Extra 3119 West was ready and that he should make an air brake test as soon as a car inspector was on hand. The engineer and head brakeman then walked to the locomotive unit, but the conductor and flagman remained in the yard office which was about 1,500 feet from their train. Although it was customary for two car inspectors to inspect and test an outbound train, only one inspector was available. This man stated that he initiated the air brake test from the head end of Extra 3119 West, and after the brakes were applied, he walked to the rear of the train, checking brake shoes, brakepipe angle cocks, and brake cylinder piston travel. The inspector asserted that he crossed over between the cars whenever he could not see a car's brake cylinder because it was on the opposite side of the center sill. He did not, however, inspect the cars' branchpipe cutout cocks. After observing the brakes apply on the cars and having found no defects, the inspector used his portable radio to instruct the engineer to release the brakes. After the caboose brake released, he boarded the caboose and observed that the gauge in the cupola indicated brakepipe pressure of more than 85 pounds. The inspector then returned to the locomotive where he asked the engineer if everything was "O.K." When the engineer replied affirmatively, the inspector assumed this meant that brakepipe leakage had not exceeded the allowable 5 pounds per minute. (See appendix D.) The inspector stated that the brake test was completed at 9:42 a.m. and that he inspected the train from the south side as it pulled by him. The conductor and flagman said they inspected the train from the north side as it pulled by the yard office and then boarded the caboose. No surviving crewmember or other employee witnessed the air brake test or could otherwise corroborate the inspector's statements concerning it.

Meteorological Information

At the time of the accident, there was high overcast with 25 miles visibility in the Cima-Kelso area. Winds were northeasterly at 5 to 10 mph. The temperature was 62° F.

Method of Operation

The accident occurred on the First Subdivision of Union Pacific's California Division, which connects Las Vegas, Nevada, with Yermo, California, a distance of 171 miles. This is a single track railroad and trains are operated by the indications of a centralized traffic control system (CTC). Normally, 22 freight trains and 2 passenger trains are operated daily across the First Subdivision. A dispatcher at Salt Lake City, Utah, supervised operations over the First Subdivision and he was under the direct supervision of an assistant chief train dispatcher, who was also located at Salt Lake City. The dispatcher routed and monitored the movement of trains as they reached and passed control points, represented by lights on the modelboard of his CTC machine. The machine was also equipped with a Traingraph, a recording instrument that tracked the movement

of trains by time and location. The dispatcher also used radio to instruct and communicate with the traincrews. There were no means for recording communications traffic to and from the dispatcher.

The dispatcher who was on duty at the time of the accident worked the first, or daylight, shift between 7:00 a.m. and 3:00 p.m. He was a salaried supervisor and had worked as a dispatcher since 1952. He stated that he was thoroughly familiar with the First Subdivision and had ridden the head ends of trains down Cima Hill as part of a continuous effort over the years to familiarize himself with the territory. The dispatcher acknowledged that there had been incidents in the past when engineers had trouble controlling their trains between Cima and Kelso, but these had not actually resulted in accidents. The dispatcher stated that he did not consider Extra 3119 West as being in an emergency situation until the train passed Elora and that, even then, he had no doubt that the VAN train was capable of outrunning Extra 3119 West. At no time did the dispatcher consider routing the VAN train into the passing track at either Dawes or Hayden so that Extra 3119 West could overtake and pass it.

Union Pacific requires dispatchers to keep trains moving in an expeditious and safe manner and they must provide proper protection for all trains in accordance with rules and special instructions. 6/ According to the dispatcher, there were no standing procedures to follow in a runaway emergency on Cima Hill, and when he notified the assistant chief train dispatcher that an emergency appeared to be developing, the assistant chief train dispatcher did not offer advice or instruction.

Cima Hill

Beginning at milepost 253.4, just west of Cima, and ending at milepost 236.1, at the east end of Kelso, the elevation above sea level drops 2,006 feet, requiring a westerly descent at a rate in excess of 2 percent. Union Pacific treats this as a sustained 2.20-percent grade compensated for curvature; the combined resistance of ascending grade and track curvature 7/ is the equivalent of an average of 2.20 percent, or a rise of 116 feet to the mile. However, the grade itself is not uniform.

Between Cima and Kelso, the UP crosses the Mojave Desert on a relatively direct line. The country is open and there are no sharp breaks in the terrain. There are only 17 curves in 17.3 miles and, collectively, the curves and their spirals comprise less than 40 percent of the alignment. The sharpest curves and the least severe fall in elevation per mile in the entire grade are between Cima and Chase. (See table 1.) The tangents are short and curves and their spirals make up more than two-thirds of this section. West of Chase, the fall in elevation becomes progressively more severe and there is progressively less curved track. Straight track comprises more than 6 of the 8 miles between Elora and Hayden and in this section there are tangents of 0.9, 1.4, and 2.3 miles.

Between Cima and Kelso there are four controlled 6,500-foot passing tracks--Chase, Elora, Dawes, and Hayden, from east to west. All were clear at the time of the accident. The distances between the opposing turnouts of these passing tracks are: Cima to Chase, 2.43 miles; Chase to Elora, 1.92 miles; Elora to Dawes, 2.74 miles; Dawes to Hayden, 2.67 miles; Hayden to Kelso, 2.21 miles. The VAN train could have fit into any of the passing tracks with about 1,000 feet to spare between the insulated joints. All of the passing tracks had No. 14 turnouts with a maximum speed of 20 mph

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6/ Union Pacific Railroad Company Form 2274, Instructions for Train Dispatchers, effective May 1, 1972.
7/ One degree of curvature offers the same resistance as 0.05 percent grade. (See appendix F.)

Table 1.—Union Pacific track between Chase and East Kelso.

	Distance (miles)	Tangent Track (miles)	Curved Track (miles)	Fall in Elevation (ft)	Average Fall per Mile (ft)	Average Actual Gradient (%)	Grade Equivalent of Curvature (%)	Descending Grade Compensated for Curvature (%)
m.p. 253.4 to Chase (m.p. 250.44)	2.96	0.86	2.10	337	113.8	2.155	0.052	2.103
Chase to Elora (m.p. 247.28)	3.16	1.91	1.25	366	115.8	2.193	0.013	2.180
Elora to Dawes (m.p. 243.27)	4.01	2.78	1.23	464	115.7	2.191	0.014	2.177
Dawes to Hayden (m.p. 239.35)	3.92	3.27	0.65	456	116.3	2.202	0.006	2.196
Hayden to East Kelso (m.p. 236.1)	3.25	1.75	1.50	383	117.8	2.231	0.012	2.219

authorized by the timetable. A maximum of 5 minutes delay had to be allowed from the time the dispatcher encoded his CTC machine to align the turnout to any of the passing tracks to the time the command was actually executed. The turnout could be reversed as soon as the train cleared the insulated joint inside the passing track.

Union Pacific System Timetable No. 4 was in effect on November 17, 1980, (see appendix C) and authorized a 70-mph maximum speed for freight trains between Yermo and Erie, which included the section between Cima and Kelso. This was subject to the maximum authorized speed for a train as noted on the clearance form issued to the train's conductor and engineer, as well as to lesser speeds stipulated in the timetable for westbound trains between Cima and Kelso. These speeds were 35 mph for trains controlled exclusively with dynamic braking, and 25 mph for trains not required to use retainers. California Division Special Rule 1042 (RC) in the timetable stipulated that any train exceeding 3,500 tons could not be controlled exclusively with dynamic brakes. VAN train Extra 8044 West fell under the provisions of this rule and was, hence, restricted to 25 mph. The rule also required that retainers be used on trains between Cima and Kelso when; (1) they exceeded 85 tons per operative brake; (2) they exceeded 80 tons per operative brake and had less than 2-horsepower dynamic braking per trailing ton, or; (3) had less than 1-horsepower effective dynamic braking per trailing ton. UP air brake rule 1042(A), (see appendix D) restricted any train using retaining valves to 20 mph. However, Special Rule 1042(RC) further restricted trains which fell under the 3rd category to 15 mph on Cima Hill and required that they be stopped for 10 minutes at Dawes to cool wheels. Extra 3119 West fell under this category of the rule.

Air Brake Rules

There was no rule or special instruction requiring the determination that a locomotive unit's dynamic braking feature was functional before it was assigned to a train at Las Vegas or elsewhere on the Union Pacific. California Division Special Rule 1042 (RC) required only that westbound trains handled by a locomotive not equipped with a brakepipe pressure maintaining feature had to make a dynamic braking test on the downgrade west of Erie. However, counterparts of this rule on the Utah and Wyoming divisions required this type of testing on all freight trains before they were allowed to descend designated grades. California Division Superintendent's Circular No. 47, issued effective January 2, 1980, instructed engineers that locomotive "units will not be dispatched...without dynamic brakes functioning on lead unit." In the event dynamic brakes failed en route, the circular instructed engineers to contact the train dispatcher and be governed by his instructions. (See appendix E.) The circular was cancelled on August 12, 1980. It could not be determined what may have prompted the issuance of the circular or its subsequent cancellation.

Las Vegas is a designated 500-mile inspection point and all trains leaving there are required to receive the initial terminal air brake inspection and testing prescribed by various UP air brake rules. 8/ (See appendix D.) These rules require that the inspection and testing be initiated after it has been determined that the brakepipe has been charged to within 15 pounds of the feed valve setting on the train's locomotive, as indicated by an accurate gauge connected to the brakepipe at the rear of the train. After a prescribed test has established that brakepipe leakage does not exceed 5 pounds per minute, the train's braking system must be inspected to determine that the brakes on all cars apply and release; that retaining valves and retaining valve pipes are in serviceable condition; that angle cocks, brakepipe end cocks, cut-out-cocks, and retaining valve handles are in

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8/ The requirements of these rules generally conform with what is required by the Power Brake Law (49 CFR 232.12)

the proper position; that brake rigging is properly secured and does not bind or foul; and that air hoses are serviceable and properly coupled. Body-mounted brake cylinders with piston travel of less than 7 inches or more than 9 inches must be adjusted to nominally 7 inches. UP Air Brake Rule 1058(A) states that when brake cylinder piston travel exceeds 10 inches, the air brakes cannot be considered to be in effective operating condition. After the brakes have been released, inspectors and trainmen must know that air pressure has been restored or is being restored as indicated by the caboose gauge.

UP "Rules and Instructions Governing the Operation of Air Brakes" also included the following rules applicable to the management of trains on mountain grades:

> 1039(A.) Dynamic brake must be supplemented by use of train air brakes to extent necessary to properly control speed of train.
>
> 1043. When starting freight trains from summit of heavy descending grades and pressure maintaining method of braking is to be used, care must be used to avoid making first reduction too heavy as this would reduce speed of train to extent brakes would have to be released.
>
> If first reduction was not sufficient to hold train, further brake pipe reductions of one or two pounds each may be made until amount is reached where train will be held at desired speed.
>
> Equalizing reservoir gauge must be frequently observed and if any increase in pressure is shown on this gauge during time brakes are applied, this pressure should be promptly reduced to the amount indicated by this gauge before increase occurred.
>
> 1043 (A). When starting freight trains from summit of heavy descending grades and "short cycle" method of braking is to be used, first application of brakes must be made as soon as practicable without stalling, to test holding power of brakes while speed is slow and to get the additional aid of retaining valves if their use is required. All subsequent brake applications must be of sufficient amount to hold train at required speed, and when releasing if necessary, "Release" or "Running" position of automatic brake valve must be used until air brake system has recharged and brakes are to be reapplied. Subject to local restrictions, speed must correspond with holding power of brakes and ability to fully recharge, maintaining as nearly as possible a uniform speed. Light applications are best, but must not be so light as to prevent getting a sufficient reduction in speed to insure recharging before again reaching too high a speed. To determine the extent to which pressure in brake system is being recharged, brake pipe pressure as indicated just before releasing must be observed. If pressure is gradually reducing and cannot be regained by slower speed, train must be stopped and air brake system recharged. When retaining valves are being used, it is practical to release at slower speeds.

Union Pacific had no rule, special instruction, or bulletin to indicate to engineers the maximum service brakepipe reduction that could be used safely in an effort to arrest acceleration on a heavy descending grade.

Air Brake Rule 1052 stipulates that the conductor's, or caboose, brake valve must not be used except in an emergency. There is no rule or instruction that requires the

conductor to inform the engineer that he has applied the air brakes from the caboose valve. Rule 1052(A) reads, "When conductor's valve or caboose valve is opened while train is moving, under no circumstances must it be closed before the train has stopped." Rule 1053(A) required the engineer to place the automatic brake valve in "Emergency" position in the event an emergency brake application was initiated from any source other than the automatic brake valve. In the event that a service application of the automatic brake was initiated from a source other than the automatic brake valve, the following air brake rule applied:

> 1053. If brakes in train are applied with service application from any source other than from use of automatic brake valve on locomotive while using power, engineer must leave brake valve in "Running" or "Release" position, keep locomotive brake released, and close throttle gradually as speed of train reduces. When train has reached point where it is evident it will stop within next 100 feet, throttle must be closed, rails sanded, and independent brake fully applied as train comes to stop. This procedure must also be followed when not using power except with respect to use of throttle. After stop is completed, engineer must make or observe that not less than a ten (10) pound brake pipe reduction has been made from equalizing reservoir pressure, and must permit this application to equalize throughout train before releasing train brakes.

Union Pacific does not have divisional or regional air brake supervisors, and with the advent of its formal engineer training program, UP discontinued the use of air brake instruction cars to provide local air brake training to supervisors and employees. As a result, there is no provision for training brakemen and conductors on the air brake rules. The conductor and rear brakeman of Extra 3119 West stated that they had never received formal, comprehensive training on air brakes.

Survival Aspects

Locomotive 3119 remained upright and in line with the track but had virtually all of the carbody torn from the frame as a result of being overridden. (See figure 5.) The engineer and head brakeman were ejected from the unit and their bodies were found on the ground south of the main track. The engineer received massive blunt head injuries that were instantly fatal. The head brakeman received massive multiple injuries to the head, chest, abdomen, and extremities that were also instantly fatal.

The VAN train's caboose had both platforms crushed and the rear bulkhead was partly driven in. After derailing, the caboose carbody separated from the trucks, turned over, and slid down the south embankment on its left side. The conductor and rear brakeman were thrown to the floor. The conductor received multiple severe head, chest, and spine injuries which were fatal within minutes. The rear brakeman survived the accident with severe facial and back injuries. He was flown from the accident site to a Las Vegas hospital in a "Flight for Life" rescue helicopter.

Tests and Research

Although the operator compartment of UP 3119 was demolished, it was possible to determine most of the locomotive's control settings after the accident. The throttle was found in "Idle," the reverser was in "Forward," the selector was in "Power," and the brake valve cut-off valve was in "Pass." The independent brake was found fully

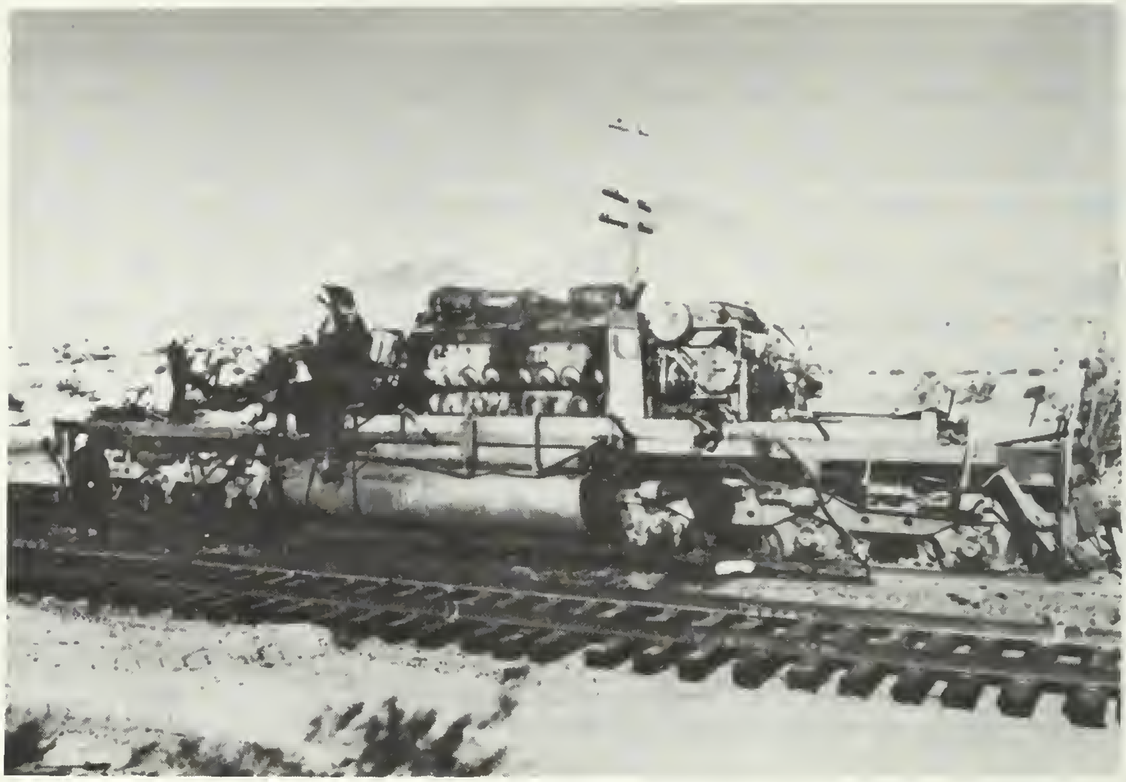

Figure 5.--Locomotive unit of Extra 3119 West where it stopped after the accident.

applied. The automatic brake valve was in release with the handle appearing to have been struck and possibly moved. The unit's brake shoes were all worn away, and all the wheels had discolored rims. Metallurgical examination at UP's laboratory indicated that all the wheels had been uniformly overheated to 900-950° F throughout the full rim section. Post-accident testing of the unit's air brake valve determined that it functioned normally. A legible tape was recovered from the speed recorder of UP 3119 and calibration of the recorder indicated that there was no variation between actual and recorded speeds up to 32 mph and only nominal difference at higher speeds. (See appendix J.) Because the recorder was accurate at lower speeds, the tape was analyzed to determine the time and relative locations of variations which occurred in indicated speed. It was possible to establish that a dramatic increase in acceleration occurred at 20 mph, about 18 1/2 minutes and 4.6 miles into the run. The maximum 79-mph speed that could be recorded was reached 12 1/2 miles west of the starting point at Cima. Analysis of the speed tape indicated that Extra 3119 West attained its maximum rate of retardation during the descent, about 2.5 mph per minute, following the brake application made after the train cleared the passing track at Cima.

The caboose valve was found in the fully open, or emergency position. The hand brakes of the caboose had not been applied. The angle cock on the forward end of the car was open; the angle cock on the rear was closed. The brake cut-out cock was open and the retainer valve was in the direct release position.

Most of the tie cars of Extra 3119 West were thrown from the track with such force that the cars' trucks were completely dismantled and it was impossible to reconstruct them or to ascertain which wheelsets had been under a given car. The brake rigging of most of the cars was destroyed and only 32 of the 160 brake shoes were recovered.

About half of these had more than half the original thickness remaining. Retainer valves were found on 18 cars, and of these, 12 were in the heavy holding position, 2 were broken, 3 were in direct release position, and 1 was in indirect pressure position. Thirteen of the undamaged retainer valves functioned normally under test. Of the tie car brake valves recovered, 11 functioned normally under test, 2 had some leakage but were operable, and 1 leaked due to damage. Branchpipe cut-out cocks were found in the closed, or out, position on the 11th, 15th, and 18th head cars. Brakepipe angle cocks on the rear of the 3rd and 17th head cars were found closed but both had been struck during the derailment. The forward angle cock of the 18th head car was also found closed, half-buried in the sand. During the handling of the tie cars at Las Vegas, these cars had not been uncoupled at the ends where the angle cocks were found closed.

Of 78 tie car wheelsets recovered and sent to UP's laboratory for examination, 25 showed no thermal evidence, 29 showed discoloration indicating heating to less than 400° F, 12 had indications that they were heated to 400-700° F, and 2 appeared to have been heated to 750-800° F. (See appendix I.) Thirteen wheelsets displayed evidence of overheating on only one wheel. The ten remaining wheelsets had thermal evidence, if any, obliterated by rust or corrosion. The UP laboratory report stated that no evidence was found to indicate "any abnormal heating not commonly seen in normal train service." The report also stated that there was no significant evidence of slid flats, tread smear, or deformation apparent in any wheel.

In order to determine the efficiency of the brake rigging of the tie cars, the UP tested an undamaged car of the same class as those in Extra 3119 West. This car had a light weight of 80,000 pounds and a gross allowable weight of 220,000 pounds. Total brake shoe force at 50 pounds brake cylinder pressure was found to be 32,605 pounds which was 40.75 percent of the light weight and 14.8 percent of the gross weight. These compared favorably with the maximums of 53 and 13 percent for light and gross weights, respectively, specified by the Manual of Standard and Recommended Practice of the Association of American Railroads.

Following the accident, UP made up a test train with a SD40 unit similarly equipped to the 3119, a caboose of the same class as that on Extra 3119 West, and 20 serviceable class F-70-1 tie cars similar to the cars in Extra 3119 West. A number of the test train cars were reloaded with ties salvaged from the accident site and all the test cars were weighed after loading. Four cars were only partly loaded and the test train was found to have 9,695 ties on board, more than 1,000 less than had been on Extra 3119 West. The 16 fully-loaded test train cars had an average gross weight of 201,031 pounds and the full trailing weight of the test train was 1,948.25 tons.

The test train cars were inspected and repaired as necessary to meet the requirements of UP air brake rules. Brake cylinder piston travel was adjusted to nominally 7 inches on all of the cars and a total of 18 brake shoes were changed out on 10 cars. Prior to adjustment, piston travel had been in excess of 10 inches on 6 cars and from 9 to 10 inches on 7 cars. The test train included 3 cars that had been switched out of the tie train on November 17. One had 9-inch piston travel and had two brake shoes changed; the second had 9 1/2-inch piston travel and had two brake shoes changed; and the 3rd had 11-inch travel and had one shoe changed.

The test train was first used in static testing at Las Vegas. Employing various reductions of the brakepipe pressure at varying time intervals, it was shown that with pressure maintaining and functioning retainers used in heavy holding position, it was virtually impossible to dissipate the train's brakepipe air supply to the point of no

recovery through manipulation of the locomotive brake valve. Road testing was preceded by an inspection and test of the train's air brakes at Cima which revealed that a tie car had developed a cylinder leak that rendered its brakes only partially effective. All other cars had fully effective brakes and the dynamic brake was not used. The test train started from the north passing track at Cima and was operated by an experienced retired UP supervisor with Safety Board investigators observing from both ends of the train. No effort was made to exactly duplicate the speed tape of Extra 3119 West and the caboose valve was not opened during the testing. The train was started by releasing the independent brake, opening the throttle to the No. 1 position, and advancing throttle to the No. 3 position when speed reached 10 mph. When the train had moved about 1,000 feet, but had yet to enter the main track, a 10-pound brake application was made to decelerate from 13 mph. The throttle was then progressively advanced to the No. 5 position accelerating the train to 16 mph by the time it had traveled three-fourths of a mile. Acceleration was arrested by reducing throttle, the brakepipe reduction was increased to 17 pounds at 15 mph, and 15 seconds later the brakes were released against the retainers. Thereafter, speed was cycled between 9 and 18 mph by successive 10-pound applications and releases against retainers, and manipulation of the throttle. The train was stopped from 15 mph by the combination of gradual throttle reduction and a 10-pound brake application at a point 4.7 miles west of Cima--the approximate location where Extra 3119 West had begun uncontrolled acceleration.

Additional static tests were made at Las Vegas to determine the effect of an emergency application initiated from the caboose after the brakepipe had been depleted from a full charge. Tests were made with brakepipe pressures of 64 (full service), 60, 57, 50, and 37 pounds. The emergency application propagated through the train and the locomotive unit only in the case of the full service reduced brakepipe. In each instance where the reduction was beyond full service, the emergency application failed to transmit to the locomotive and the locomotive brake valve's pressure-maintaining feature began restoring brakepipe pressure in less than one minute. This caused a partial release of the brakes throughout the train and further depletion of pressure in the cars' emergency reservoirs. According to UP's director of train operating practices, it would be necessary to quickly place the locomotive brake valve in emergency position in order to nullify the action of the pressure maintaining feature. Even then, restoration of emergency brake cylinder pressure and adequate braking capability could not be achieved as long as the caboose valve remained open. The test results were later confirmed in testing performed for the Safety Board by the Westinghouse Air Brake Company at their Wilmerding, Pennsylvania test rack.

Other Information

Air Brake Association

The Air Brake Association manual Management of Train Operation and Train Handling, 1977 edition, (see appendix F) relates that operating freight trains down grades of any significant length requires an ability to "balance the grade" by achieving zero acceleration, or holding speed steady at safe and practical values, while maintaining an ample safety margin of service brake available to stop normally anywhere on the grade. To hold speed steady on a downgrade, the force of gravity must be balanced by the sum of train resistance and brake retarding force. The heavier, or steeper, the grade, the lower the effect of train resistance and the more braking required. The increase of a few tons in weight per car can also be critical in the ability to balance the grade since there must be a nearly corresponding increase in braking force. Each added ton of train weight on a 2.20-percent descending grade adds 44 pounds to the force of gravity while providing

only 4 pounds of added train resistance at 15 mph, according to calculations in the Association's manual. Short trains with high gross weights per car are particularly sensitive to this since a greater workload is imposed on wheels and brake shoes than is the case with longer trains of cars of moderate average weight.

According to the Association, the amount of train brake retarding force used to balance the grade normally should not exceed one-half of the normal full service train brake available if dynamic brake and pressure maintaining are operative. When pressure maintaining is available but dynamic brake is not, the amount of brake required to balance the grade should not exceed one-third of normal full service. (At 90 pounds brakepipe pressure, full service is 26 pounds.) Since speed can get out of control in a very short time on heavy grades, it is stated that the engineer should not hesitate to use an emergency application to stop the train.

The Air Brake Association recommends that when cycle braking against retainers, "The initial application should be started at a point that will prevent speed from becoming excessive as the train moves out onto the grade and before the application becomes effective on the whole train. There is no substitute for good judgment and experience." Additionally, it is recommended that the initial application be held until speed is under the average required before the brakes are released against the retainers. When pressure maintaining is being used, the Association recommends that the engineer be alert for, (1) brakes being applied from the rear end, and (2) bad leakage having developed in the brakepipe. If the locomotive unit is not equipped with a brakepipe flow indicator with indicator light, the engineer can detect the increased flow of air into the brakepipe through the automatic brake valve resulting from either situation by observing main reservoir pressure dropping rapidly and compressors loading repeatedly.

Rules of Other Railroads

The Baltimore and Ohio (B&O), Denver & Rio Grande Western (D&RGW), Burlington Northern (BN), and Southern Pacific (SP) railroads all operate over mainline grades that are at least as long as Cima Hill, descend at sustained rates of at least 2 percent compensated for curvature, and over which trains of bulk commodities are commonly operated. In each instance, these railroads have specific and straightforward air brake rules and/or timetable instructions covering the management of trains on their mountain grades, which go beyond what is provided by UP in their air brake rules. (See appendix G.)

Burlington Northern classifies any extended grade of 1.80 percent or more as a mountain grade and has special rules to cover such operations which include long 2.20-percent grades in the Cascade Range of Washington. The stipulated method of moving all freight trains down these grades is the combination of dynamic braking and a service application of the air brakes of not less than 5 to 7 pounds. Trains which average 100 tons or more per operative brake must carry 100 pounds of pressure in the brakepipe. It is not permitted to reduce brakepipe pressure by more than 18 pounds to balance the grade. Trains averaging 80 to 99 tons per operative brake must carry 90 pounds in the brakepipe and are permitted a maximum service reduction of 15 pounds. At four places in BN's Mountain Grade Rules, this admonition appears in bold type: "AN EMERGENCY BRAKE APPLICATION SHOULD BE MADE WITHOUT HESITATION SHOULD ANY CONDITION OCCUR WHERE THERE IS DOUBT OF ABILITY TO CONTROL TRAIN SPEED."

Southern Pacific has a number of long 2.00- to 3.00-percent grades in the Cascades of Oregon and Sierra Nevadas of California, as well as the 40-mile, 2.20-percent grade in southern California known as Beaumont Hill. SP rules require engineers of all freight trains to perform a running test of the automatic air brake before descending these heavy grades. Also, SP rules require that a train must be stopped immediately if a reduction of 13 pounds (one-half of full service) is insufficient to balance the grade.

Bulk trains descending Baltimore and Ohio's 2.00-percent Seventeen Mile Grade between Altamont and Piedmont, West Virginia, must slow to 8 mph passing the summit and once acceleration begins, the engineers are required to make a minimum brakepipe reduction of not less than 8 pounds to be followed by application of the dynamic brake. If the grade cannot be balanced by a combination of dynamic braking and a maximum of 15 pounds service reduction, the train must be stopped. The train may not descend the remainder of the grade until retainers have been set up, hand brakes have been applied, and brakepipe pressure fully restored. Continuous use of the automatic brake for more than 2 miles is prohibited in any event.

There are numerous notable grades on the Denver & Rio Grande Western (D&RGW) including the 37-mile, 2.00-percent descent down the front range of the Rocky Mountains from Moffat Tunnel to the suburbs of Denver; the 22-mile 3.00-percent descent from Tennessee Pass to Minturn, Colorado; and the 30-mile, 2.00-percent downgrade from Soldier Summit to Thistle, Utah. Both Colorado grades are characterized by near-constant curvature up to 12 degrees. The Utah grade has 9-degree curves. D&RGW timetable rules define a bulk train as any which averages 80 or more tons per car, which has functioning dynamic brake, and has trailing tonnage in excess of that specified for the various locomotive models. In the case of an SD40 unit, the specified minimum is 1,300 tons. If a bulk train can not balance the grade with the combination of dynamic braking and a maximum of 18 pounds service reduction, the train must be stopped and sufficient retainers set up and hand brakes applied to hold the train on the grade. The crew must then notify the chief dispatcher who, in turn, is advised by the superintendent of air brakes or road foreman of equipment as to what course of action is to be taken. The rules provide that this procedure must also be followed with a bulk train with inoperative dynamic brake before the train begins descending the grade. In actual practice, however, even trains with inoperative dynamic brake which do not qualify as bulk trains are not allowed to start down the grade before receiving instructions from the chief dispatcher.

ANALYSIS

The Makeup and Inspection of Extra 3119 West

Extra 3119 West was not an ordinary work train. In fact, it was as expedited a train as any on UP's California Division on the morning of November 17, 1980. A large mechanized tie gang was on location about 160 miles west of Las Vegas with no ties to install. It had taken only 3 1/2 days to move a consignment of more than 10,000 main track crossties 1,260 miles from UP's timber treating plant in Oregon to Las Vegas. When the tie cars arrived at Las Vegas shortly after midnight, supervisors there had already placed a caboose on the No. 5 yard track and they had the inbound freight crew place the block of cars containing the tie cars against the caboose. An extra board crew was available for Extra 3119 West and, with a timely departure from Las Vegas, the train could have been at the work site well before noon so that most, if not all, of the ties could have been distributed along the right-of-way during daylight hours. However, the only caboose available had an inoperative electrical system and the marker lights could not be illuminated as required between an hour before sunset and an hour after sunrise. As a result, the crew was not called to report for duty until 8:05 a.m., long after the train had been switched.

About 20 minutes before the Extra 3119 West crew was due to report, the Las Vegas terminal superintendent was told that the train included 5 cars of 8-foot yard ties that could not be used in the main track and that these would have to be replaced with cars of 9-foot ties that had been switched out during the night. Although he first refused to allow it, the terminal superintendent saw to it that a yard crew coming on duty was immediately put to work reswitching Extra 3119 West. The terminal superintendent personally directed the switching to assure that it was expedited. Perhaps a good indication of the haste with which the switching was done, was the mixup of numbers that resulted in Extra 3119 West leaving behind one of the cars of main track ties and taking in its place a car of 8-foot yard ties. The Safety Board believes that considering the delays that had been incurred, and the manner in which the switching was done, the subsequent inspection of the train was also hurried in an effort to expedite matters.

Extra 3119 West required thorough inspection and testing, not only because this was dictated by UP's rules and Federal law, but because the train would have to traverse long and heavy grades to reach its destination. Only one car inspector was available and he improperly initiated the brake test from the head end of Extra 3119 West without first determining whether or not there was any air in the brakepipe at the rear of the train. The car inspector stated that he did not make the required check to see if the cars' brakes were cut out and inoperative. He also stated that he did not ask the engineer if there had been any brakepipe leakage, but assumed that leakage had not exceeded the allowable 5 pounds per minute. The car inspector found no defects and he made no adjustments or repairs. According to the inspector, not 1 of the 160 tie car brake shoes needed to be replaced. Since there were no new brake shoes distributed along, or nearby the No. 5 track, the inspector would have had to go a considerable distance to obtain a replacement had one been needed.

Before Extra 3119 West departed from Las Vegas, the conductor was told that 1,495 tons was the trailing weight of his train. This was not the sum of the weights shown on the waybills for the cars, but it was 5 tons less than 1,500 tons which was one-half the dynamic braking horsepower of the locomotive unit. Giving the conductor this incorrect figure authorized the crew of Extra 3119 West to operate their train down Cima Hill at 35 mph without stopping to set up retainers and to cool wheels, thereby avoiding a substantial delay to the train.

The waybills for the tie cars that had been in Extra 3119 West were prepared at UP's The Dalles treating plant and were dated November 13, 1980. The date, destination, consignee, description, and weight of "Est 60,000" were typewritten. The car numbers, and the number and length of ties, were apparently added later to the waybills in handwriting. Inquiries made at the tie plant developed that the estimated 60,000-pound weight was arbitrarily applied to all shipments regardless of the type and number of ties loaded on the cars. No effort was made to estimate the weight on the basis of the individual shipment.

Safety Board investigators established that there were 9,695 9-foot ties on the test train that UP assembled at Las Vegas, compared with the 10,789 ties that had been on board Extra 3119 West. Most of the test train ties were recovered from the accident site and were a mixture of the hardwood and softwood varieties. With the ratio of hardwood to softwood on the test train probably similar to that of the original consignment, about 3 to 1, the average weight per tie on the test train was estimated at 232.55 pounds. Using this as a basis and taking into account the carload of 8-foot yard ties, the total lading weight of Extra 3119 West was conservatively calculated to be 2,456,000 pounds, more than double the total shown on the waybills. The total weight of the train, therefore,

including the locomotive, was probably 2,245 tons compared to the 2,198.74-ton estimate based on average tie weights stated by UP's expert witness; and the 2,177.56-ton estimate made by UP's mechanical department.

Crew of Extra 3119 West

Since it was classed as a work train, Extra 3119 West had to be manned by a crew drawn entirely from the newer and less experienced employees who were on the extra board. The crewmembers assigned to Extra 3119 West were qualified under UP rules, but they averaged only 16 months experience in road service out of Las Vegas. The conductor had been promoted 7 months before. He and the brakemen received all of their formal training when they were switchmen on UP's Los Angeles terminal, and this included little on the air brakes that would be of use to them in the management of their train on a mountain grade such as Cima Hill. The engineer was described as an apt and capable graduate of UP's engineer training program and he had successfully handled many conventional trains down the Cima-Kelso grade. However, the investigation failed to disclose any evidence that he had acquired sufficient knowledge and expertise necessary for successfully descending this grade with a short train with high-gross weight per car and grossly inadequate braking capability.

Braking Capability of Extra 3119 West

The engineer of Extra 3119 West had been informed that his train had a trailing weight of only 1,495 tons (71.2 tons per car) and as far as he knew, all of the cars in the train had operative brakes. With pressure maintaining and dynamic braking features of the locomotive in operating condition, the engineer was permitted by the timetable to operate the train from Cima to Kelso at 35 mph. He would not have to stop at Cima to set up retainers, but he would have to reduce speed to 25 mph passing over the crest of the grade at Cima. Had Extra 3119 West weighed 1,495 tons (1,691 tons including locomotive), the downward grade force of gravity, at 44 pounds per ton of train weight, would total 74,404 pounds on the 2.20-percent grade. Nominal train resistance of 7,369 pounds 8/ combined with the 60,000-pound braking force provided by the dynamic braking of the locomotive would very nearly have balanced the gravity force. A light reduction of 7 to 8 pounds brakepipe pressure with the equivalent of 3 to 4 effective car brakes might have been required on the lower half of Cima Hill where the grade was the steepest to augment the dynamic braking and control speed.

Had the engineer been told that the weight of Extra 3119 West, including locomotive, was about 2,245 tons rather than 1,691 tons as supposed, Rule 1042(RC) required that Extra 3119 West would have to be stopped at Cima and retainers set up. Also, a 20-mph maximum speed was imposed by Rule 1042(A). As the descending gradient increased progressively from -1.822 percent to -2.176 percent between Cima and Chase, the grade force of gravity in excess of the train's rolling resistance would increase from 74,543 to 90,437 pounds. Had the dynamic brake been operative, the remaining grade force that would have to be balanced by train braking force would ultimately require the equivalent of 10 fully-operative car brakes while still leaving an adequate reserve of braking capability to stop the train if necessary. (See table 2.)

Without dynamic braking, Extra 3119 West's air brake system had to be relied upon entirely to balance the 90,437-pound grade force at 15 mph by the time the train reached Chase, less than 3 1/2 miles from the starting point. Table 3 indicates that once the train had started down the -1.822-percent compensated grade, it was not possible to balance

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8/ Train rolling resistance is calculated here and elsewhere in this report on the basis of the Davis formula. (See appendix F.)

Table 2.--Extra 3119 West--Number of Effective Car Brakes Required With Fully Effective Dynamic Braking Capability to Balance Grade at 20 mph.

Train Weight--4,490,000 lbs.

Pounds Brakepipe Reduction	-1.822% No. of Brakes (13,838 lbs.) Required	-2.102% No. of Brakes (26,410 lbs.) Required	-2.176% No. of Brakes (29,732 lbs.) Required
7	8.1	15.6	17.5
8	7.1	13.6	15.3
9	6.3	12.1	13.6
10	5.7	10.9	12.3
11	5.2	9.9	11.1
12	4.8	9.1	10.2
13	4.4	8.4	9.4

the grade at 15 mph and also retain any margin of brakepipe pressure for stopping if necessary. To balance the -1.822-percent grade, the train would have needed a full-service 26-pound reduction and fully effective brakes on 12 of its 21 cars. Once on the -2.176-percent grade, a minimum of 14.4 effective brakes were required at full service to stabilize speed and there would be no reserve of braking capability other than the locomotive's independent brake.

Table 3.—Extra 3119 West--Number of Effective Car Brakes Required without Effective Dynamic Braking Capability to Balance Grade at 15 mph.

Train Weight--4,490,00 lbs.

Pounds Brakepipe Reduction	-1.822% No. of Brakes (74,543 lbs.) Required	-2.102% No. of Brakes (87,115 lbs.) Required	-2.176% No. of Brakes (90,437 lbs.) Required
15	20.5	----	----
16	19.2	----	----
17	18.1	21.2	----
18	17.1	20.0	20.7
19	16.2	18.9	19.7
20	15.4	18.0	18.7
21	14.7	17.1	17.8
22	14.0	16.4	17.0
23	13.4	15.7	16.2
24	12.8	15.0	15.6
25	12.3	14.4	14.9
26	11.8	13.8	14.4

Postaccident examination indicated that three of the cars of Extra 3119 West probably had their brakes cut out and inoperative. The engineer of Extra 3135 West observed Extra 3119 West smoking heavily as it passed Chase. This indicated that the engineer of Extra 3119 West had made a very heavy application of the train brakes and that actual braking effort was being provided by only a few cars in the train. The laboratory examination of 78 tie car wheelsets revealed no evidence of abnormal heating not commonly seen in ordinary train service. There were no slid flat spots or other deformations which would have probably occurred during a prolonged episode of continuous heavy braking. Little or no thermal evidence was found on 54 wheelsets. Based on the foregoing, the Safety Board concluded that six cars probably had ineffective brakes and another seven cars had only partially effective brakes. Since another 10 wheelsets had arrived at the laboratory in rusted or corroded condition and it was not possible to determine whether they had been overheated, there may have been other cars with less than fully effective brakes.

Twenty of the surviving 35 F-70-1 tie cars were assembled at Las Vegas about 10 days after the accident. The condition of these cars as they were received is also probably indicative of the condition of the cars that were in Extra 3119 West. Six of the cars were found to have ineffective brakes while 10 of the cars had only partially effective brakes. The three cars in the test train which had been in Extra 3119 West as it was first constituted were probably representative of the cars that left Las Vegas in Extra 3119 West. None of these cars had fully effective brakes.

The test train operated by UP was useful in that it revealed that a train composed of 20 loaded tie cars and a caboose with 20 fully effective brakes could be operated without dynamic braking down Cima Hill safely by a veteran engineer and supervisor who was called out of retirement for the demonstration. Extensive precautions were taken, including 2 days of inspecting and repairing the tie cars at Las Vegas and the performance of a complete brake inspection and test before the train left Cima. The test cannot be properly considered as a simulation of the operation of Extra 3119 West since that train was not repaired, inspected, or tested before it descended the grade and the engineer did not have the depth of experience and expertise possessed by the man who operated the test train. Table 4 gives the braking calculations for the test train between Cima and Chase. Interestingly, the test train balanced the grade with the equivalent of about 20 1/2 effective brakes and a total brakepipe reduction of 17 pounds at 15 mph.

The Descent from Cima

Analysis of the speed tape from UP 3119, together with the radio reports attributed to the engineer and statements of surviving crewmembers, give considerable insight into what probably occurred after the train left Cima. Aside from the discovery that the locomotive's dynamic brake was inoperative, nothing untoward appears to have occurred prior to the start down the grade. Erie Hill had not put the train's air brake system to any real test nor had it alerted the engineer to inadequacies in braking capability. The speed tape indicated that the only place on Erie Hill where some form of braking action was taken was on a 3.2-mile section with an average -0.91-percent descent. The braking action was probably taken after the engineer had tried the dynamic brake and found it to be inoperative. Acceleration on the downgrade was arrested at 57 mph and held at that level for 1.4 mile before deceleration began in a long curve. A modest brake application that was effective on some of the cars would have been sufficient to produce that response.

Table 4.—UP Test Train Extra 3114 West--Number of Effective Car Brakes Required to Balance Grade Without Dynamic Braking Capability at 15 mph.

Train Weight--4,288,500 lbs.

Pounds Brakepipe Reduction	-1.822% (71,617 lbs. Required)	-2.102% (83,625 lbs. Required)	-2.176% (86,799 lbs. Required)
14	21.1	----	----
15	19.7	----	----
16	18.5	----	----
17	17.4	20.3	21.1
18	16.4	19.2	19.9
19	15.5	18.1	18.8
20	14.8	17.2	17.9
21	14.1	16.4	17.0
22	13.4	15.7	16.3
23	12.8	15.0	15.6
24	12.3	14.4	14.9
25	11.8	13.8	14.3
26	11.4	13.3	13.8

Table 5.--Movement of Extra 3119 West from Cima to Milepost 248.8 Analyzed from Speed Tape

Milepost Reference	Distance from Start		Speed in MPH	Time in Minutes	Acceleration Rate MPH per Min.	
253.8	0.0		0.0	0.00	0.00	
253.7	0.1	1°30' L.H. curve	8.0	1.50	5.33	
253.6	0.2		12.0	2.10	6.67	End-1.115%
253.5	0.3	Turnout	14.0	2.56	4.33	Begin-1.822%
253.4	0.4	No. Passing Track	16.0	2.96	5.00	End-1.822%
253.3	0.5		17.5	3.32	4.19	Begin-2.102%
253.2	0.6		16.5	3.67	-2.83	
253.1	0.7		15.5	4.05	-2.67	
253.0	0.8		14.0	4.45	-3.69	
252.9	0.9	2° L.H. curve	13.5	4.89	-1.15	
252.8	1.0		14.5	5.32	2.33	
252.7	1.1		15.0	5.73	1.23	
252.6	1.2		15.5	6.12	1.27	
252.5	1.3		16.0	6.50	1.31	
252.4	1.4		16.0	6.88	0.00	
252.3	1.5		15.5	7.26	-1.31	
252.2	1.6	2° R.H. curve	15.0	7.65	-1.27	
252.1	1.7		15.0	8.05	0.00	
252.0	1.8		16.0	8.44	2.58	

Milepost Reference	Distance from Start		Speed in MPH	Time in Minutes	Acceleration Rate MPH per Min.	
251.9	1.9		17.0	8.08	2.75	
251.8	2.0		17.5	9.15	1.44	
251.7	2.1		17.0	9.50	-1.44	
251.6	2.2		16.5	9.85	-1.40	
251.5	2.3	1° L.H. curve	15.5	10.23	-2.67	
251.4	2.4		15.0	10.62	-1.27	
251.3	2.5		15.5	11.02	1.27	
251.2	2.6		16.0	11.40	1.31	
251.1	2.7		16.5	11.77	1.35	Turnout East
251.0	2.8		17.0	12.12	1.40	End Chase
250.9	2.9		17.0	12.48	0.00	Passing Track
250.8	3.0		16.5	12.84	-1.40	
250.7	3.1		15.5	13.21	-2.67	
250.6	3.2		15.0	13.60	-1.27	
250.5	3.3	1° R.H. curve	15.0	14.00	0.00	End-2.102%
250.4 Chase	3.4		15.5	14.40	1.27	Begin-2.176%
250.3	3.5		16.0	14.78	1.31	
250.2	3.6		17.0	15.14	2.75	
250.1	3.7		17.5	15.49	1.44	
250.0	3.8		17.5	15.83	0.00	
249.9	3.9		18.0	16.17	1.48	Turnout West
249.8	4.0		18.0	16.50	0.00	End Chase
249.7	4.1		18.5	16.83	1.52	Passing Track
249.6	4.2		19.0	17.15	1.56	
249.5	4.3		19.5	17.46	1.06	
249.4	4.4	0°30' R.H. curve	20.0	17.77	1.65	
249.3	4.5		20.0	18.07	0.00	
249.2	4.6		20.0	18.37	0.00	
249.1	4.7		21.0	18.66	3.42	
249.0	4.8		22.0	18.94	3.58	
248.9	4.9		23.0	19.21	3.75	
248.8	5.0		25.0	19.46	8.00	

If the engineer of Extra 3119 West had any misgivings about the braking capability of the train, he did not express them to the conductor or dispatcher. And if he had any anxiety about his ability to manage the train successfully on Cima Hill, it is doubtful that he would have followed the VAN train from Cima as soon as the passing track home signal aspect changed from "stop" to "approach."

Because the downgrade force of gravity became progressively greater as Extra 3119 West descended from Cima, it was necessary to establish almost immediately that the available braking force was sufficient to balance the grade. It is possible that the engineer understood this and made a minimum brake application before leaving the passing track inasmuch as there was a decrease in the rate of acceleration at milepost 253.6 where the grade steepened to -1.822 percent. The only UP rule that applied in the situation cautioned against making the initial brakepipe reduction too heavy and then instructed the engineer that if the first reduction was not heavy enough, he should make further light reductions until the desired speed could be held. The engineer

had probably made the first reduction at 12 mph, desiring to ultimately control speed at the required 15 mph. After entering the main track and reaching the place at milepost 253.4 where the average gradient steepened to -2.102 percent, the engineer made another brakepipe reduction. This began to slow Extra 3119 West with the maximum rate of deceleration being achieved once the entire train was in the first 2-degree curve beginning at milepost 253.2. However, acceleration occurred again while the train was still in the curve. This development must have troubled the engineer and should have caused doubt as to whether or not speed could be controlled. At this point, the engineer might have been able to stop the train, if not with an immediate reduction to full service, then most likely with an emergency application of the brakes. There was still half of the first 2-degree curve to stop in, but the train would soon be running out of curves and onto even steeper gradient. Overheating and overload of the wheels and brake shoes would soon reduce braking efficiency of those cars that had braking capability. However, the UP rules did not tell the engineer to stop his train if there was any doubt that speed could be controlled nor was there any rule or instruction requiring the retention of sufficient brakepipe pressure to be able to do this.

Another partial brakepipe reduction again arrested acceleration and reduced the speed once the entire train was in the second 2-degree curve beginning at milepost 252.4. Thereafter, additional brakepipe reductions resulted in brief episodes of deceleration which always occurred in curves and which were quickly followed by reacceleration. Braking never resulted in reducing speed sufficiently or stabilizing speed long enough to permit the engineer to risk releasing the brakes against the retainers. By the time the train reached Chase, the engineer had the brakes in full service, the independent brake was applied, and the engineer had informed the dispatcher that he was in trouble. This report alarmed the conductor who placed the caboose valve in emergency without communicating with the engineer. Once the valve had been opened, a UP rule required that it be kept open. Although the conductor and rear brakeman tried to uncouple the caboose, they did not think to apply the caboose hand brake or the hand brakes on the cars ahead.

The speed tape analysis (see table 5) shows that there were two last, brief interruptions of acceleration after Extra 3119 West passed Chase. The first was probably achieved by increased application of the independent brake and/or the automatic brake beginning at milepost 250.5. Although the engineer had been taught not to go beyond full service to the "suppression" position, he probably did so in desperation after reporting that he had the independent brake fully applied. The second interruption in acceleration, at milepost 249.9, lasted less than a minute and probably resulted from the emergency application made by the conductor. It was immediately followed by a burst in acceleration which progressively increased at a phenomenal rate. As shown in postaccident testing, the logical explanation for this occurrence was the failure of the emergency application to be transmitted to the locomotive and the resultant partial release of the brakes due to the locomotive pressure-maintaining feature restoring air to the brakepipe. Had the locomotive been equipped with a brakepipe flow indicator, the rush of air through the brake valve would have caused the indicator to light and would have alerted the engineer to what was happening. By placing the brake valve in emergency position, he could have stopped the flow of air to the brakepipe. Without a flow indicator, there was no way the engineer could know that an emergency application had occurred unless told so by someone in the caboose. Even if he had detected the drop in trainline pressure that occurred, the engineer could not have determined that this had been caused by an emergency application instead of a service application. In addition, a rule required him to leave the brake in "Running" or "Release" position and keep the

independent brake released when a service application was made from elsewhere in the train. With the brake valve in any position other than the emergency position, the brakes were released in less than a minute and there was no way that braking capability could be recovered as long as the caboose valve remained open. In a very short time, only the independent brake of the locomotive was providing retardation.

Role of Dispatcher

From the time the engineer of Extra 3119 West reported that his dynamic brake was inoperative to the time the engineer of the VAN train reported the collision, the dispatcher failed to properly respond to the situation. In addition, the assistant chief dispatcher said and did nothing after he learned that an emergency was developing. This same apparent detachment and lack of concern that run counter to the traditional role that dispatchers play in the operations of all railroads was cited by the Safety Board in its report on the rear-end collision of two UP trains near Hermosa, Wyoming, on October 16, 1980. 9/ The dispatcher was experienced, had firsthand knowledge of Cima Hill, and was aware of problems westbound trains had encountered descending the grade in the past. He was the immediate supervisor of the traincrews and he should have known that the engineer and other crewmembers of Extra 3119 West were inexperienced. It was the dispatcher's responsibility to provide proper protection for all trains and to guard against dangerous conditions in their movement. He should have known that a short, heavy train without dynamic braking could be hard to handle on the grade even for a seasoned engineer. The dispatcher had the time to consult with other supervisors and to work out a safe solution to the situation before Extra 3119 West was allowed to descend Cima Hill. He could have stopped the VAN train at Cima to exchange one of its trailing units for the 3119. Failing this, he could have had a supervisor with the necessary expertise advise the engineer as to how he should handle Extra 3119 West on the grade. Finally, the dispatcher should have held Extra 3119 West at Cima until the VAN train was well down the hill and out of danger.

When the engineer of Extra 3119 West reported that he was in trouble, the VAN train was about 4 1/2 minutes from the east turnout of Dawes passing track and about 4 miles ahead of Extra 3119 West. The dispatcher probably could have averted the accident by immediately acting to align the turnout at Dawes to the passing track and instructing the VAN train engineer to slow down sufficiently to allow for the time it would take for the CTC command to be executed. Slowing down the VAN train would also have given the men on that train's caboose an opportunity to evacuate it. As it developed, the VAN train would probably have cleared into the passing track 2 or 3 minutes before Extra 3119 West reached Dawes. The UP, however, had no contingency plans that could be followed in the event of an emergency on Cima Hill, and the dispatcher would have had to react immediately to the initial trouble report. Had Extra 3119 West been held at Cima until the VAN train reached Chase, there would have been more than ample time to put the VAN train into the Hayden passing track. As it was, however, the only passing track that could have been used by the VAN train was Dawes. Extra 3119 West closed too fast for the VAN to use Hayden.

Once it became obvious that Extra 3119 West was out of control, the VAN engineer took matters into his own hands. Hearing the engineer of Extra 3119 West repeatedly report his speed as being 80 mph, the VAN engineer believed the other train had reached maximum speed and that he could outrun it. Had he been instructed to do this earlier

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9/ "Railroad Accident Report--Rear-End Collision of Union Pacific Railroad Company Freight Trains, near Hermosa, Wyoming, October 16, 1980" (NTSB-RAR-81-3).

by the dispatcher, he might have succeeded in staying ahead of the runaway. The VAN train ultimately failed to stay ahead of Extra 3119 West because its overspeed device caused a power loss and resultant loss of speed. Ironically, this probably prevented the derailment of the VAN train ahead of the collision since it is unlikely that the rigid 8-wheel trucks of the lead locomotive unit could have negotiated the curve west of Kelso at a speed much higher than the VAN train was making. It is doubtful that any crewmember of the VAN train would have survived such a derailment and subsequent ramming by Extra 3119 West.

Adequacy of Current UP Air Brake Rules and Instructions

The Safety Board's investigation revealed that UP made significant changes in the methods of operating westbound freight trains down the Cima-Kelso grade many years after the use of steam locomotives was discontinued and diesel-electric locomotives with dynamic braking were put into service on the First Subdivision. In the past, the crews of all westbound trains had to make a running test of the dynamic brake on Erie Hill and were required to stop at Cima to make a brakepipe air test and inspect their trains before starting down the grade. Westbound trains with inoperative dynamic brake had to be stopped for 10 minutes at both Chase and Dawes, and the crews had to make walking inspections of their trains at both places. No train was allowed to descend Cima Hill with more than 70 tons per operative brake, and empty cars were kept at Cima so that they could be added to trains which exceeded the per brake tonnage limit. At the time of the accident, there was no limit to the allowable tonnage per operative brake; the running dynamic brake test had to be made only by trains with locomotives lacking the pressure-maintaining feature; and the brakepipe test and inspection at Cima were no longer required. Trains with inoperative dynamic braking had to stop only at Dawes, and the crews were no longer required to make a walking inspection of their trains.

In the past, trainmasters and other supervisors spent much of their time observing brake tests and inspections at Yermo and Las Vegas, checking piston-travel at Cima and Kelso, and otherwise ensuring that the rules and instructions were complied with. Supervisors and trainmen, as well as engineers, were given extensive and periodic instruction on the air brakes. The Safety Board's investigation revealed that these practices were no longer being followed at the time of the accident. There is a greater need than ever before for better instructions, safeguards, training, and supervisory oversight due to a very substantial increase in typical axle loadings of freight cars used for bulk commodities, and a major increase in the number of heavy bulk trains moving over UP to west coast ports. Enginemen no longer serve a long apprenticeship before being qualified as engineers. The engineer of Extra 3119 West was trained and qualified in 6 months and he had no prior experience in train service.

As demonstrated by UP Rule 1039(A), the dynamic brake has become UP's primary method of retarding a train on a grade with the train air brakes relegated to a supplementary role when necessary. It is not, however, at all unusual for the dynamic braking feature to become inoperative, and when this occurs, the train must have an air brake system which will function properly. When deprived of their primary means of braking on a grade, enginemen must know what to do and when to do it. Air brake rules and train handling instructions should set forth explicitly the safe procedures to follow when braking power is diminished or other conditions arise which reduce the ability to control speed on steep grades.

The recommendations of the Air Brake Association and the rules of the other railroads cited in this report differ in some respects, but the underlying intent of all is the common desire to prevent the most feared event in railroading--the irrevocable loss of control of trains descending mountain grades. The framers of these rules and the managers who endorsed them recognized that emergencies and failures do occur, that allowances must be made for the less experienced employee, and that the movement of heavy trains down long, steep grades is a difficult and dangerous business under the best conditions. The Safety Board believes that the UP's rules and instructions, as well as the manner in which its operations are conducted, do not adequately take these principles into consideration. This may explain why the runaway and the difficult-to-control train have become a problem relatively unique to the UP in the past few years. 10/

The Safety Board believes that Extra 3119 West was dispatched from Las Vegas with less than half its train brakes in fully effective condition, and as a direct consequence, the engineer was unable to control the train's speed on Cima Hill. The car inspector who performed the required inspection and testing of Extra 3119 West at Las Vegas was experienced. He knew what to look for and he should have discovered the defects. Considering that it required the Las Vegas car department more than 2 days to adjust and repair the 20 tie cars UP later assembled for a test train, it is doubtful that UP's Las Vegas facilities were adequate to quickly and properly dispose of a job of the magnitude represented by Extra 3119 West. Since all 20 cars in the train were urgently needed at the other end of the subdivision and the train had already been substantially delayed, the car inspector probably understood that there was little chance that additional delay would be tolerated.

The manner in which Extra 3119 West was tested and inspected was no isolated aberration brought about by special circumstances. The engineer of the VAN train testified that his train received the same abbreviated attention by a car inspector before it departed from Las Vegas. Written instructions had been issued to car inspectors to take no more than 15 minutes to inspect and test expedited trains. (See figure 6.) There was no way that this could be done properly by one or two inspectors walking a train that might be a mile in length or longer. The Safety Board's investigation has developed that trains have continued to be operated over the California Division First Subdivision without proper inspection and testing. In one documented instance, a trainmaster acting under instructions from an assistant superintendent ordered a crew, under threat of removal from service for insubordination, to take a train from Yermo to Las Vegas after the crew protested that the train's braking system was defective. Upon approaching the yard at Las Vegas, the engineer was unable to stop the train short of a "stop" signal. 11/

10/ "Railroad Accident Report—Derailment of Union Pacific Railroad Freight Train, Granite, Wyoming, July 31, 1979" (NTSB-RAR-79-12). "Railroad Accident Field Investigation--Derailment/Collision of Union Pacific Freight Trains, Granite, Wyoming, October 13, 1979" (NTSB-DEN-80-FR-001). "Railroad Accident Field Investigation--Derailment of Union Pacific Freight Train, Albany, Wyoming, February 11, 1980" (NTSB-DEN-80-FR-013). "Railroad Accident Report—Rear End Collision of Union Pacific Railroad Company Freight Trains, near Hermosa, Wyoming, October 16, 1980" (NTSB-RAR-81-3).

11/ Extra 3493 East (BNSL-14), originated at Yermo on February 14, 1981, destined for Salt Lake City Utah. As formally reported by the Brotherhood of Locomotive Engineers, a party to the NTSB investigation, and confirmed by NTSB investigators. The incident was also the subject of a formal complaint made by the United Transportation Union to the Office of Safety, Federal Railroad Administration on March 24, 1981.

UNION PACIFIC RAILROAD COMPANY
MAILGRAM

Las Vegas - March 16, 1979

Mr. M. Palipkonich
Mr. L. P. Valdez
Mr. E. T. Murdock
Mr. H. H. Stump

Mr. F. H. Adamson
Mr. J. F. Warth, Jr.
Mr. D. L. Hidinger

Trains arriving Las Vegas with the following symbols will have a 500 mile air test only and will not be delayed at Las Vegas for further inspection:

Super Van
Van
SSS
CN
LAX
LAD
SDV
CTT

These trains will depart in 15 minutes or less from arrival time unless cars are added or removed but in any case the Car Department will not delay these trains. J-57

Signed
D. L. Joy

Figure 6.--Written instructions from the Las Vegas general car foreman concerning the testing and inspection of trains by car inspectors. (reproduced by NTSB.)

The Safety Board believes that Las Vegas and Yermo may not be the only points on the Union Pacific system where trains are not receiving the required inspection and testing to assure that they are safe to operate. The cars that constituted Extra 3119 West were required to have been fully tested and inspected at least three times en route from the treating plant to Las Vegas. Many of the tie cars assembled for the test train also arrived in Las Vegas in defective condition. In its report of the investigation of a runaway freight train on Sherman Hill at Granite, Wyoming, on July 31, 1979, 12/ the Safety Board determined that the accident was caused by lack of braking capability resulting from a closed brakepipe angle cock and that the train had not been properly inspected and tested at the point where it was originated.

The Safety Board believes that present UP management policy does not foster compliance with its rules requiring air brake tests nor compliance with the provisions of the Federal Power Brake Regulations regarding the performance of train air brake tests and inspections, and that what has been observed by Safety Board investigators following a number of serious accidents on the UP is a direct reflection of that policy. Following the Granite investigation, the Safety Board recommended on January 10, 1980, that UP "Instruct employees who make train brake tests in the test requirements of the Federal Power Brake Regulations, CFR 49 Part 232, and establish monitoring procedures to insure that the tests are conducted properly." Although more than 1 1/2 years have passed since this recommendation was made, the Safety Board has not received a response from UP management.

The basis of the Federal regulations requiring train air brake tests is the Power Brake Law of 1958 (Public Law 85-375) by which Congress required the Interstate Commerce Commission to place into effect as Federal regulations for the sole purpose of safety, the rules, standards, and instructions of the Association of American Railroads (AAR) for the installation, inspection, maintenance, and repair of all power or train brakes used by common carriers engaged in interstate commerce. Since 1968, the responsibility for enforcing this law has been vested in the Federal Railroad Administration (FRA) which maintains safety inspectors in the field for this purpose. Following the Granite investigation, the Safety Board recommended that FRA "Enforce the requirements for testing train brakes in accordance with the Federal Power Brake Regulations, 49 CFR Part 232, on the Union Pacific Railroad." On April 7, 1980, FRA responded that they had a strong program in effect for the enforcement of the Power Brake Regulations and also favored a policy of permitting the railroads to improve compliance with the law through their own internal training programs. On June 3, 1980, the Safety Board responded to FRA by describing FRA's response as unacceptable and asking for advice as to what FRA had done specifically in the case of Union Pacific to improve compliance with the law. FRA has never answered this letter and there is no indication that FRA has stepped up its enforcement activity on the Union Pacific.

FRA is currently considering the publication of a notice of proposed rulemaking, apparently with the intention of eliminating or modifying some of the provisions of the Federal Power Brake Regulations on the basis that the advent of dynamic braking and other changes in technology have made them obsolete. However, this accident and those which preceded it on the UP have demonstrated that there is still a compelling need for minimal requirements for inspecting and testing the air brake systems of trains at the points where they are assembled. Indeed, as trains become heavier, the requirements should become more comprehensive and enforcement of the requirements must become

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12/ "Railroad Accident Report--Derailment of Union Pacific Railroad Freight Train, Granite, Wyoming, July 31, 1979", NTSB-RAR-79-12.

stricter. FRA should make no modifications to the regulations which will adversely affect the safety of train operations.

CONCLUSIONS

Findings

1. UP wanted Extra 3119 West dispatched expeditiously from Las Vegas to a track work site near Yermo.

2. Extra 3119 West was delayed for about 6 hours at Las Vegas because its caboose had an inoperative electrical system and could be operated only during daylight hours.

3. A last-minute need to switch the train further delayed Extra 3119 West. The work was done hurriedly under the supervision of the Las Vegas terminal superintendent who was accountable for the delay.

4. Extra 3119 West left Las Vegas without receiving a proper and adequate inspection and test of the air brake system.

5. The lading of the 20 tie cars in Extra 3119 West was estimated on the waybills to be 1,200,000 pounds which was less than half the actual weight.

6. It was the practice of UP's timber treating plant at The Dalles, Oregon, to arbitrarily underestimate the weights on the waybills of crosstie shipments from the plant, even though the approximate weights of the various grades and sizes were known.

7. UP's methods of operation on Cima Hill and other mountain grades were predicated on tonnage per operative brake. The traincrews, therefore, should be given figures which accurately reflect the actual tonnage and number of operative brakes in the train.

8. UP had no rule or special instruction limiting the tonnage per car or locomotive unit that a train could have descending Cima Hill.

9. The engineer of Extra 3119 West discovered that the locomotive dynamic brake was inoperative after the train left Las Vegas and he reported the fact to the dispatcher. However, no provisions were made to provide the train with a replacement unit or to determine that the engineer knew how to handle a train down the grade without dynamic brake.

10. The engineer of Extra 3119 West understood the timetable restrictions for his train and he attempted to operate the train accordingly. The investigation did not reveal any evidence to indicate that the engineer and other crewmembers were in other than normal and alert condition at all times.

11. The crew of Extra 3119 West set up the retainers of their cars as required by the timetable instructions. However, the engineer was never able to stabilize the train's speed long enough at the desired level to release the brakes against the retainers.

12. The engineer was considered to be a capable and rules-conscious employee, but the Safety Board believes he lacked the experience and expertise to manage a train with inadequate braking capability on Cima Hill.

13. Because there is less fall in elevation and there are more curves at the top of the Cima-Kelso Grade than at any other part of the grade, a train unable to balance the grade immediately after leaving Cima, would not be able to balance the grade beyond that section.

14. To balance the grade between Cima and Chase with a minimum of 18 pounds brakepipe reduction, Extra 3119 West had to have fully effective brakes on all the cars in the train. The minimal number of effective brakes needed to balance the grade with a full service application of the brakes was 14.4; analysis of the wreckage of Extra 3119 West indicated that at least 13 of the train's 21 cars did not have fully effective brakes. The crew was not aware of this.

15. UP's rules and instructions do not inform an engineer how much brakepipe pressure he may expend attempting to balance a grade nor how much pressure should be retained for stopping ability.

16. UP's rules and instructions do not require that a train be stopped if there is doubt that speed can be controlled with a given amount of braking.

17. The conductor placed the caboose valve in emergency when Extra 3119 West was moving at about 20 mph with the train brakes in full service or beyond. He was not required to tell the engineer he had done this, but he was required to leave the caboose valve open. The emergency application did not transmit to the locomotive.

18. The brakes released following the emergency application because the brake valve pressure-maintaining feature began restoring air to the brakepipe. Since the locomotive did not have a brakepipe flow indicator, there was no way the engineer could tell whether a service or emergency application had been made from the caboose.

19. Had the locomotive been equipped with a brakepipe flow indicator, the engineer probably would have realized that the brakes had been applied in emergency and by quickly placing the locomotive brake valve in emergency position, he could have nullified the action of the pressure-maintaining feature. Having failed to do this, there was no way braking capability could be restored as long as the caboose valve remained open.

20. If the engineer interpreted that the conductor had made a service application, the engineer was obliged by UP Rule 1053 to keep the locomotive brake valve in "running" or "release" position.

21. Although the engineer of Extra 3119 West told the dispatcher that he was in trouble when at or near Chase, the dispatcher took no action of any kind. UP had no contingency or emergency plan for action in the event a train ran away on Cima Hill.

22. The engineer of the VAN train took matters into his own hands and tried to outrun Extra 3119 West but was unable to do so because the locomotive overspeed feature had functioned causing a loss of power. If this had not occurred, the VAN train probably would have derailed in a curve west of Kelso.

23. The test train operated by UP proved that a train composed of 20 loaded cars and a caboose, with 20 fully effective brakes could be operated safely down Cima Hill by an expert engineer without using dynamic braking.

24. Twenty tie cars similar to those in Extra 3119 West were assembled for the test train. Before being repaired, 6 of these cars had ineffective brakes and 10 had only partially effective brakes. This was probably a fair indication of the condition of Extra 3119 West when it descended Cima Hill.

25. The only applicable UP rule instructs enginemen to continue making brakepipe reductions until they are able to control speed at the desired level. There is no recommended or required limit as to how much total reduction an engineer may make in the process.

26. Compared with the recommendations of the Air Brake Association and the rules of other railroads applying to mountain grade operations, the UP rules are inadequate because they do not provide necessary safeguards and safety procedures.

27. The Safety Board believes that UP management policy does not foster compliance with the air brake test rules and Federal Power Brake Regulations; consequently, UP trains are not being inspected and tested properly.

28. The Federal Railroad Administration is not adequately enforcing the Federal Power Brake Law on the Union Pacific Railroad.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the dispatcher's permitting Extra 3119 West to leave Cima with inadequate braking capability, the inadvertent release of the train's brakes after they were placed in emergency from the caboose, and the UP's inadequate rules and instructions for the management of trains on mountain grades that resulted in the engineer's inability to control the speed of the train. Contributing to the accident were the failure to properly inspect and test Extra 3119 West at Las Vegas, the inadequate maintenance of braking equipment on tie cars used in company service, and the practice of underestimating the weight of loaded tie cars. Contributing to the severity of the accident were the lack of effective direction by the dispatcher and assistant chief train dispatcher and the absence of emergency procedures for train operations on Cima Hill.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the Union Pacific Railroad Company (UP):

Provide traincrews with accurate tonnage figures for their trains at Las Vegas and other locations where operating methods are predicated on tonnage per operative brake. (Class II, Priority Action) (R-81-88)

Require that The Dalles, Oregon, timber treating plant and other UP facilities where material is loaded on cars provide actual weights on waybills where track scales are available. Where scales are not available, require that weights be accurately estimated. (Class II, Priority Action) (R-81-89)

Amend its timetable instruction pertaining to the operation of westbound trains between Cima and Kelso without functioning dynamic braking to provide for:

(1) A maximum tonnage per operative brake that is consistent with the braking force required to balance grade force;

(2) The requirement that a running air brake test be performed in advance of Cima;

(3) Establish the maximum brakepipe reduction that may be made in the effort to balance the grade; and

(4) Caution traincrews that in case there is any doubt of ability to control speed, the train must be stopped immediately, sufficient hand brakes set to hold the grade, and brakepipe fully restored before the train is allowed to proceed. (Class II, Priority Action) (R-81-90)

Issue instructions to the California Division chief train dispatcher that require First Subdivision dispatchers to:

(1) Ascertain that crews of westbound trains without functioning dynamic brakes understand the special timetable provisions applying to their trains between Cima and Kelso;

(2) Determine that engineers of westbound trains at Cima fully understand the proper method of braking on the grade;

(3) Hold westbound trains without functioning dynamic brakes at Cima until the main track is clear to Kelso and not permit the occupancy of the main track east of Kelso by other trains while a train without functioning dynamic brakes is descending the grade. (Class II, Priority Action) (R-81-91)

Require that the dynamic braking feature of the lead locomotive unit on all westbound trains originating at Las Vegas and which are to be operated west of Cima be tested and determined to be functional. (Class II, Priority Action) (R-81-92)

Amend its air brake and train handling rules to:

(1) Require crewmembers to notify the engineer whenever the caboose brake valve is used;

(2) Expand Rule 1043 to include references to the necessity of retaining sufficient brakepipe pressure to stop anywhere on the grade; and

(3) Modify Rules 1053 and 1053(A) to eliminate the possibility of an inadvertent release of the brakes after an open brakepipe occurs and this fails to result in an emergency brake application on the locomotive. (Class II, Priority Action) (R-81-93)

--to the Federal Railroad Administration (FRA):

Conduct a safety review of the Union Pacific Railroad Company to determine that compliance with Federal Power Brake Regulations (49 CFR 232) is enforced effectively at Las Vegas, Nevada, Yermo, California, and other initial terminal points, and provide the Safety Board with a report of the findings. (Class II, Priority Action) (R-81-94)

Retain the minimal requirements of the Federal Power Brake Regulations (49 CFR 232) for the inspection and testing of trains at the points where they are originated. (Class II, Priority Action) (R-81-95)

In addition to these recommendations, the Safety Board reiterates and reemphasizes the importance of the following recommendations which were made as the result of other accidents on the Union Pacific Railroad:

--to the Union Pacific Railroad Company:

Instruct employees who make train brake tests in the test requirements of the Federal Power Brake regulations, CFR 49 Part 323, and establish monitoring procedures to insure that the tests are conducted properly. (Class II, Priority Action) (R-79-78) This recommendation is currently held in "Open" status; no response has been received from UP.

Equip locomotives with brakepipe flow indicators to enable engineers to measure trainline air flow. (Class II, Priority Action) (R-79-81) This recommendation is currently held in "Open--Acceptable Action" status; UP responded on March 4, 1980, that pending results of tests then being conducted by the Association of American Railroads (AAR), UP would withhold further application of flow indicators to their locomotive units. On April 28, 1980, the Safety Board acknowledged this response and requested being advised of the results of the study and UP's ultimate decision in the matter. No further advice has been received from UP.

Amend and clarify rules to require dispatchers and train crewmembers to communicate with each other about conditions affecting the movement of their train. (Class II, Priority Action) (R-81-42) This recommendation is currently held in "Open" status; no response has been received from UP.

--to the Federal Railroad Administration:

Enforce the requirements for testing train brakes in accordance with the Federal Power Brake Regulations, 49 CFR, Part 232, on the Union Pacific Railroad. (Class II, Priority Action) (R-79-82) This recommendation is currently held in "Open—Unacceptable Action" status. FRA responded on April 7, 1980, stating that FRA believes adherence to regulations is best accomplished through the railroad's own training programs and proficiency testing. The Safety Board replied on June 3, 1980, noting that FRA's response did not directly address the recommendation and asking what had been done to improve compliance on UP. No further response has been received from FRA.

Review the monitoring system for rule compliance on the Union Pacific Railroad to insure that their supervisors can adequately enforce the rules to provide a safe and efficient operation. (Class II, Priority Action) (R-79-84) This recommendation is currently held in "Open--Acceptable Action" status. FRA responded on April 7, 1980, stating that FRA's 5-year review of annual operational tests by UP indicated an increase in observed failures of rules, and that the results would be studied and analyzed with NTSB to be informed of the findings by the summer of 1980. The Safety Board acknowledged FRA's response on June 3, 1980, and asked to be kept informed. No further advice has been received from FRA.

Study the feasibility of requiring locomotives to be equipped with brakepipe flow indicators to enable engineers to measure trainline air flow. (Class II, Priority Action) (R-79-85) This recommendation is currently held in "Open--Acceptable Action" status. FRA responded on April 7, 1980, stating that FRA would include the feasibility of requiring brakepipe flow indicators under proposed revisions to Power Brake Regulations. The Safety Board acknowledged FRA's response on June 3, 1980, and asked to be informed when definite action had been taken. No further advice has been received from FRA.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

JAMES B. KING, Chairman, did not participate.

August 18, 1981

APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

Investigation

The National Transportation Safety Board was notified of the accident about 5:30 p.m., P.s.t., on November 17, 1980. The Safety Board immediately dispatched an investigator from the Los Angeles Field Office to Kelso and, subsequently sent an investigative team from Washington, D.C. to the scene. Investigative groups were established for operations, vehicle factors, track and signals, and human factors.

Depositions

The Safety Board conducted a 1-day deposition proceeding on February 19, 1981, at Las Vegas, Nevada, as part of its investigation of this accident. Parties to this proceeding included the Union Pacific Railroad Company, the Federal Railroad Administration, the Brotherhood of Locomotive Engineers, and the United Transportation Union. Testimony was taken from eight witnesses.

APPENDIX B

TRAIN CREWMEMBER INFORMATION

EXTRA 3119 WEST

Conductor David Alan Branson

Conductor Branson, 26, was employed by the Union Pacific Railroad as a yard switchman at Los Angeles, California, on October 16, 1973. He transferred to the extra board at Las Vegas, Nevada, on April 20, 1979, and on April 7, 1980, he passed the various examinations for promotion to conductor.

Mr. Branson last passed a company physical examination in July 31, 1978, and he was last examined on the timetable rules and air brake rules at the time of his promotion. He was not restricted in any way.

Engineer David LeRoy Totten

Engineer Totten, 31, was employed by the Union Pacific Railroad as a sectionman on January 30, 1974. On July 17, 1978, he entered UP's formal training program for engineers and he completed the classroom training phase on September 7, 1978. According to UP's director of train operating practices, who was in charge of the engineer training program at the time, Engineer Totten was a "very apt student: very capable," and he scored a mark of more than 96 percent on the final examination. After extended on-the-job training, Mr. Totten was qualified as an engineer on January 17, 1979.

Mr. Totten was not restricted in any way. He had last passed a company physical examination on July 24, 1976; the examination on mechanical rules on August 24, 1978; the examination on the operating rules on or about September 7, 1978; and the air brake rules on May 17, 1979.

Rear Brakeman Thomas Cecil Faucett

Brakeman Faucett, 30, was employed by the Union Pacific Railroad as a switchman at the Los Angeles, California, terminal on June 26, 1978. On February 9, 1980, he transferred from Los Angeles to road service out of Las Vegas. He was not promoted. Mr. Faucett was last examined on the operating rules on April 3, 1980, and he was not restricted.

Head Brakeman Wallace Dean Dastrup

Brakeman Dastrup, 22, was employed by the Union Pacific Railroad as a switchman on May 2, 1979. He worked one tour of duty at Las Vegas, was furloughed, and worked on the Los Angeles terminal until October 16, 1979, when he was transferred to road service at Las Vegas. He was not promoted.

Mr. Dastrup last passed a company physical examination on April 9, 1979, and an examination on the operating rules on November 2, 1979. He was not restricted in any way.

APPENDIX C

EXCERPTS FROM UNION PACIFIC RAILROAD SYSTEM TIMETABLE NO. 4, OCTOBER 26, 1980

CALIFORNIA DIVISION

WESTWARD				FIRST SUBDIVISION (PACIFIC TIME)	EASTWARD		
TATION IUMBER	LENGTH OF SIDINGS FEET	FIRST CLASS 35 DAILY		Timetable No. 4 STATIONS	MILE POST	FIRST CLASS 36 DAILY	RULE 6(B)
9-1479		9.05AM		DN-R LAS VEGAS	334 3	A7 20PM	FPY
				5 2			
9-1484	5876			BRACKEN	329 1		P
				1 7			
9-1486	3403			BOULDER JCT.	327 4		PY
				4 9			
9-1490	6480			ARDEN	322 5		PY
9-1491				BLUE DIAMOND SPUR	321 8		P
				7 0			
9-1498	5212			SLOAN	314 8		P
				5 5			
9-1504	5690			ERIE	309 3		P
				8 0			
9-1512	5730			JEAN	301 3		P
				4 9			
9-1517	5791			BORAX	296 4		P
				8 8			
9-1526	6116			CALADA	287 6		P
				10 1			
9-1535	5774			NIPTON	277 5		P
				5 1			
9-1541	5769			MOORE	272.4		P
				5 0			
9-1545	5761			IVANPAH	267.4		P
				4 2			
9-1550	5760			BRANT	263 2		P
				5 3			
9-1555	5226			JOSHUA	257 9		P
				3 9			
9-1559	5088 5272		CTC	CIMA	254 0		PY
				3 6			
9-1563	5667			CHASE	250 4		P
				3.1			
9-1566	5723			ELORA	247 3		P
				4 0			
9-1570	5781			DAWES	243.3		P
				4 0			
9-1574	5788			HAYDEN	239.3		P
				3.9			
9-1577	9827			KELSO	235 4		PY
				9 3			
9-1587	5757			KERENS	226.1		P
				8.5			
9-1595	558			SANDS (SPUR-E)	217 6		P
				6 0			
9-1601	5758			BALCH	211.6		P
				8 1			
9-1609	5765			CRUCERO	203 5		P
				6 5			
9-1616	6198			BASIN	197 0		P
				5 2			
9-1621	640			AFTON (SPUR-E)	191 8		P
				4 4			
9-1626	6116			DUNN	187 4		P
				5.1			
9-1631	5718			FIELD	182.3		P
				4 8			
9-1635	5771			MANIX	177 5		P
				9 5			
9-1645	5686			TOOMEY	168 0		P
				4 9			
9-1650				DN-R YERMO	163 1		FPY
				(171.2)			

CALIFORNIA DIVISION SPEED RESTRICTIONS — FIRST SUBDIVISION

LOCATION	MPH PSGR	MPH FRT
Maximum Speed		
Between Yermo and Erie	79	70
Between Erie and Las Vegas	79	60
Between Mile Posts —		
Yermo		
162.0 and 162.75	60	60
162.75 and 163.75	20	20
Field		
186.1 and 187.1	70	60
Dunn		
188.4 and 191.6	55	45
191.8 and 194.1	50	40
194.4 and 196.2	55	45
Flynn		
230.9 and 231.2	70	60
Kelso		
246.5 and 246.7	45	45
251.3 and 254.4	45	45
Cima to MP 236		
Westward freight trains not required to use retainers per Special Rule 1042(RC)		25
Westward freight trains being controlled exclusively with dyanmic brake		35

SPECIAL RULES — FIRST SUBDIVISION and BOULDER CITY BRANCH

1042 (RC). On descending grades from Cima to Kelso and from Blue Diamond to Arden the following applies:

Train exceeding 3500 tons must not be controlled exclusively with dynamic brake.

Retaining valves must be used:

1. On any train exceeding 85 tons per operative brake.
2. On any train exceeding 80 tons per operative brake with less than two horsepower effective dynamic brake per trailing ton.
3. Any train with less than one horsepower effective dynamic brake per trailing ton. Such trains must not exceed 15 MPH Cima to Kelso and must stop and remain standing ten minutes at Dawes to cool wheels.
4. On any train being handled without pressure maintaining. Dynamic brake must be tested between MP 309 and MP 292.

Conductor must advise engineer number of cars in train, total tonnage, and tons per operative brake.

From Cima to Kelso, train not required to use retaining valves may operate at a speed not to exceed 25 MPH provided speed can be controlled with minimum brake pipe reduction (6-8 lbs.). If more than minimum brake pipe reduction (6-8 lbs.) is required to control speed, a speed of 20 MPH must not be exceeded.

Maximum speed of westward trains over crest of grade at Cima must be 10 MPH less than maximum authorized speed Cima to Kelso.

Between Kelso and MP 217.6, westward trains exceeding 75 tons per operative brake and which do not have at least one horsepower effective dynamic brake per trailing ton, must not exceed 30 MPH at any point.

In cases where a train is required to stop between Cima and Kelso, provisions of Air Brake Rule 1044 will govern.

APPENDIX D

EXCERPTS FROM UNION PACIFIC RAILROAD AIR BRAKE RULES, DECEMBER 15, 1974

GENERAL RULES

INSPECTION OF AIR BRAKE EQUIPMENT

1001. Brake and signal equipment on locomotives and cars must be inspected and tested in accordance with Department of Transportation regulations and Association of American Railroads Interchange Rules, requirements of which are covered by these rules and instructions.

INITIAL TERMINAL ROAD TRAIN AIR BRAKE TEST

1022. Except for run-through and unit run-through trains covered under Rule 1031, all trains must be given inspection and test prescribed by Rule 1025 at points —

1. Where train is originally made up.
2. Where train consist is changed other than by adding or removing a solid block of cars, and train air brake system remains charged.
3. Where train is received in interchange.

1025. After the air brake system on a freight train is charged to within fifteen (15) pounds of the setting of the feed valve on locomotive but not less than sixty (60) pounds, and on a passenger train to not less than seventy (70) pounds, as indicated by an accurate gauge connected to the brake pipe at rear end of train, and upon receipt of proper request or signal to apply brakes for test, a fifteen (15) pound brake pipe reduction must be made from pressure indicated by brake pipe gauge on locomotive, and after reduction is completed, wait thirty (30) seconds for brake pipe pressure to equalize and then check of brake pipe leakage for one minute must be made. If leakage does not exceed five (5) pounds per minute a further brake pipe reduction of ten (10) pounds must be made, and on a freight train, one long sound of locomotive whistle must be sounded to indicate brakes are applied for test. On locomotives with 26-L equipment, the equalizing reservoir pressure must be reduced approximately one pound below the brake pipe pressure before moving the brake valve cut-off valve to "Frt" or "Pass" position to avoid unintentional release of train brakes.

Inspection of train brakes must be made to determine that retaining valves and pipes are in condition for service, angle cocks, brake pipe end cocks, cut-out cocks and retaining valve handles are in proper position,and that air hose is properly coupled and in condition for service. It must be determined that brakes are applied on each car, that piston travel is correct, that brake rigging does not bind or foul and that all parts of brake equipment are properly secured.

When inspection of the application of train brakes is completed, and upon receipt of proper request or signal to release brakes, air brakes must be released. On a freight train, two long sounds of locomotive whistle must be sounded to indicate that brakes have been released. Each brake must then be inspected to see that all have released.

1025(A). If brake pipe gauge indicates leakage in excess of five (5) pounds per minute after brake pipe reduction of fifteen (15) pounds has been made for test of brakes, engineer must give one short and one long sound of locomotive whistle and place automatic brake valve in "Running" position to recharge train. Upon receipt of this signal, train must be inspected for leaks and leakage corrected, after which complete test of brakes, as prescribed by Rule 1025, must be made.

1025(B). During terminal air brake test. brakes must not be applied or released until proper signal or request has been received, except in case of excessive brake pipe leakage.

1025(C). Each train must have air brakes on all cars operative before leaving a terminal except on scale test cars which are not equipped with air brakes.

1025(D). Defects which cannot be repaired promptly must be reported to foreman of inspectors or conductor and appropriate action taken for correction.

1025(F). Trainmen must inform engineers of total tonnage and number of cars and location of loads and empties in freight trains if concentrated at either end of train.

1025(G). Before a train departs from a terminal, inspectors and trainmen must know that all hand brakes are released, hoses are properly coupled, retaining valve, angle cock, brake pipe end cock and cut-out cock handles are in proper position, and that pressure is being restored or has been restored as indicated by caboose gauge on freight or other trains so equipped.

1025(I). At initial terminal, piston travel of body-mounted brake cylinders which is less than seven (7) inches or more than nine (9) inches must be adjusted to nominally seven (7) inches.

1039(A). Dynamic brake must be supplemented by use of train air brakes to extent necessary to properly control speed of train.

BRAKE PIPE TEST

1041. Before descending heavy grades designated in Special Rules, freight trains must stop and while train is standing, and with pressure maintaining cut out, engineer must apply brakes with a ten (10) pound brake pipe reduction, and give one long sound of locomotive whistle.

A trainman must observe if brake on rear car applies, and if so, make a further brake pipe reduction by gradually opening angle cock on rear end of rear car sufficiently to register on brake pipe gauge in cab of locomotive.

When engineer observes proper reduction in pressure on brake pipe gauge, two long sounds of locomotive whistle must be given and trainman must close angle cock at rear end of train, give signal to release brakes, and observe that brake on rear car releases. Failure of brake on rear car to release indicates an obstruction in brake pipe, which must be corrected and brake pipe test repeated.

If train does not depart within thirty (30) minutes after this test is completed, test must be repeated before proceeding.

GRADE BRAKING

1043. When starting freight trains from summit of heavy descending grades and pressure maintaining method of braking is to be used, care must be used to avoid making first reduction too heavy as this would reduce speed of train to extent brakes would have to be released.

If first reduction was not sufficient to hold train, further brake pipe reductions of one or two pounds each may be made until amount is reached where train will be held at desired speed.

Equalizing reservoir gauge must be frequently observed and if any increase in pressure is shown on this gauge during time brakes are applied, this pressure should be promptly reduced to the amount indicated by this gauge before increase occurred.

1043(A). When starting freight trains from summit of heavy descending grades and "short cycle" method of braking is to be used, first application of brakes must be made as soon as practicable without stalling, to test holding power of brakes while speed is slow and to get the additional aid of retaining valves if their use is requried. All subsequent brake applications must be of sufficient amount to hold train at required speed, and when releasing if necessary, "Release" or "Running" position of automatic brake valve must be used until air brake system has recharged and brakes are to be reapplied. Subject to local restrictions, speed must correspond with holding power of brakes and ability to fully recharge, maintaining as nearly as possible a uniform speed. Light applications are best, but must not be so light as to prevent getting a sufficient reduction in speed to insure recharging before again reaching too high a speed. To deter-

USE OF CONDUCTOR'S VALVE

1052. Conductor's valve must not be used except in case of an emergency. If an immediate stop is necessary, valve must be opened fully and left open until train has stopped. When a gradual stop is desired, and type of valve will permit, handle must be moved to position No. 1 and after lapse of five (5) seconds it must be moved to position No. 2. If brakes apply with sufficient force, handle must be left in position No. 2 until train is stopped; otherwise, additional braking force can be obtained by moving handle to remaining positions at five-second intervals, leaving handle in position at which desired braking force is obtained until train is stopped. Valve handle must be moved slowly from one position to another.

1052(A). When conductor's valve or caboose valve is opened while train is moving, under no circumstances must it be closed before train has stopped.

OTHER THAN NORMAL STOPS

1053. If brakes in train are applied with service application from any source other than from use of automatic brake valve on locomotive while using power, Engineer must leave brake valve in "Running" or "Release" position, keep locomotive brake released, and close throttle gradually as speed of train reduces. When train has reached point where it is evident it will stop within next 100 feet, throttle must be closed, rails sanded, and independent brake fully applied as train comes to stop. This procedure must also be followed when not using power except with respect to use of throttle. After stop is completed, engineer must make or observe that not less than a ten (10) pound brake pipe reduction has been made from equalizing reservoir pressure, and must permit this application to equalize throughout train before releasing train brakes.

1053(A). If brakes in train are applied in emergency from any source other than by automatic brake valve, brake valve must be moved to "Emergency" position and left in this position until train has stopped and equalizing reservoir pressure has vented to zero. Sufficient brake cylinder pressure must be applied to locomotive to control slack, keeping independent brake valve handle depressed in application zone to prevent sliding or overheating wheels. After brakes are released, brake pipe pressure restored, and train brakes applied with a twenty (20) pound brake pipe reduction, pressure maintaining feature must be cut out. Leakage must then be checked to see if within prescribed limits.

If power was being used at time emergency application occurred, throttle must be moved to "Idle" position.

If dynamic brake was in use at time emergency application occurred, dynamic brake operating lever must be moved to "Off" position.

OPERATIVE BRAKES

1058. Each train must have operative air brakes on all cars, except scale test cars, while running except in case of emergency, but at no time shall the number and position of operative air brakes be less than permitted by Federal requirements.

1058(A). When piston travel is in excess of ten (10) inches, the air brakes cannot be considered in effective operating condition.

APPENDIX E

UNION PACIFIC RAILROAD COMPANY
OFFICE OF SUPERINTENDENT
CALIFORNIA DIVISION

CIRCULAR NO. 47

Los Angeles - January 2, 1980

410-22-D

TO ALL ENGINEMEN

Effective immediately units will not be dispatched on train from mechanical points without speed recorders operating or without speed tapes and units without dynamic brakes functioning on lead unit. If speed recorder or dynamic brakes fail enroute, engineer will contact train dispatcher and be governed by his instructions.

L. D. Nelson
Superintendent

POST: All Circular Notice Books

REMOVE: December 31, 1980

CC: REI AL MWV LDS WET PGW GRT ECB SJJ(10) RLB RCA REM FHB RCK EKS OWP(6) TAW ADM(2) Agents - City of Industry, Riverside, Paramount, Yermo, Fullerton, H. Z. Wagner - Harbor Belt Line

51

NTSB NOTE: - Fascimile of UP California Division Superintendent's Circular No. 47

CIRCULAR NO. 108

Los Angeles- August 12, 1980

410-22-D

TO ALL ENGINEMEN:

Effective immediately Circular No. 47, dated January 2, 1980, is hereby canceled and should be removed from Circular Notice Books and Bulletin Boards.

L. D. Nelson,
Superintendent

POST: Circular Notice Books and Bulletin Boards

REMOVE: December 31, 1980

cc - REI AL RCA JES - Salt Lake
LDS WET PGW GRT ECB SJJ(10) RLB HMD WCH ADM MVW NM - Los Angs
REM - Yerm
DRL RCK EKS WSN OWP(6)
Agents - Los Angeles, Yermo(3) Las Vegas(6) City of Industry
Paramount Riverside
H. Z. Wagner - Harbor Belt Line

APPENDIX F

EXCERPTS FROM AIR BRAKE ASSOCIATION MANUAL

Control of air to the train brake system

At the automatic brake valve the pressure of the air delivered from the main reservoirs to the train brake system is reduced by a regulating valve to the brake pipe pressure carried for the particular train service. Brake pipe pressures in common use range between 70 and 110 psi, depending on the railroad and its type of service.

In undergoing this pressure reduction air expands, increasing its ability to carry moisture (or in effect reducing the humidity of the air) so that the relative humidity of the air in the brake pipe commonly ranges between 70 and 80% of saturation.

The 26-C automatic brake valve, shown in Fig. 9, supplies the brake pipe with air which is used for the following purposes:

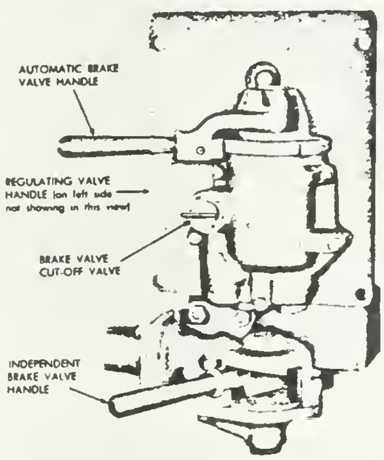


FIG. 9 26-C AUTOMATIC BRAKE VALVE

1. To charge the auxiliary, emergency and supply reservoirs of the car brake equipment and the auxiliary reservoirs of the locomotive equipment.
2. To vary the brake pipe pressure to cause the automatic train brakes to apply and release in service and emergency.

After the train is charged with the automatic brake valve handle in release position, movement to the right will cause a reduction in the equalizing reservoir pressure. This in turn will cause the brake pipe pressure to reduce a corresponding amount. Specific handle positions determine the specific pressure in the equalizing reservoir.

a. That is, leaving the brake valve handle in a position which reduced the equalizing reservoir pressure by, say 10 psi, will cause the brake pipe pressure to reduce 10 psi. Since the 26-C brake valve is of the "pressure maintaining type", the brake pipe pressure reduction of 10 psi will be held or maintained against the effect of the nominal brake pipe leakage.

b. Reducing the brake pipe pressure will cause the locomotive 26-F control valve (Fig. 11) and train brakes to apply.

c. The 26-C automatic brake valve handle positions are shown in Fig. 10 and are:

1. Release-Equalizing reservoir and brake pipe correspond to regulating valve setting, 70 to 110 psi, as required for the particular train service.

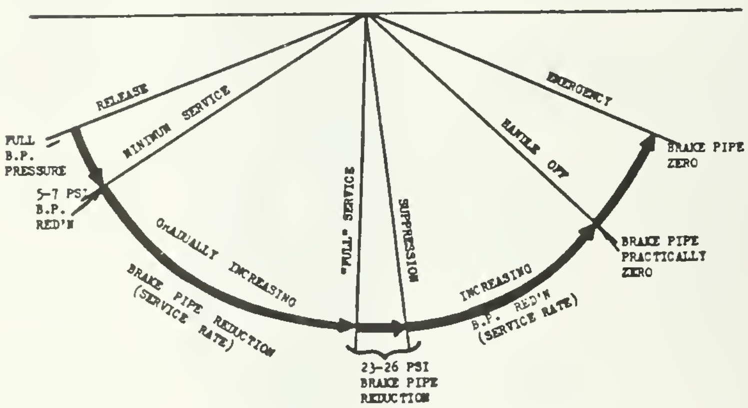


FIG. 10 26-C AUTOMATIC BRAKE VALVE HANDLE POSITIONS

2. Minimum Service Reduction: 5-7 psi reduction in equalizing reservoir and brake pipe pressure. Pressure can be further reduced in steps by moving handle progressively to the right.
3. Full service - 23-26 psi reduction of equalizing reservoir and brake pipe.
4. Suppression - 23-26 psi brake pipe reduction plus air into port #26 or "Suppression Pipe" to permanently suppress safety control or train control. Additional movement to the right toward "Handle Off" will progressively reduce brake pipe at a service rate.
5. Handle off - Brake pipe is further reduced to approximately 10 psi. Equalizing reservoir will be reduced to approximately 0.
6. Emergency - Brake pipe is quickly vented through a large opening to atmosphere and equalizing reservoir vents to atmosphere at normal rate.

Grade Operations

Operating freight trains down grades of any significant length, requires observance of the following:

a. Balancing the grade, or holding speed steady at safe and practical values.

b. Maintaining ample safety margin, or keeping speed to a value which will allow stopping the train anywhere on the grade within signal spacing or other prescribed limitations.

In order to hold speed steady on a downgrade, the force of gravity must be balanced by the sum of train resistance and brake retarding force. The heavier the grade, the lower the effect of train resistance; and the more brake must be used. Obviously, train resistance will vary with the type of cars, train make-up, and train length and weather. On heavier grades, the majority of the grade retarding force comes from the locomotive dynamic brake and the train air brake. The following conditions apply:

a. The amount of train brake retarding force used to balance the grade normally should not exceed one half (½) of the normal full service train brake available if dynamic brake and pressure maintaining are operative.

b. If pressure maintaining is available but dynamic brake is not operative, the amount of the brake required to balance the grade should not exceed 1/3 of the normal full service available.

c. With neither dynamic brake nor pressure maintaining available, cycling manipulation and use of retainers would probably be required. In this case, the train brakes are alternately applied and released. In order to insure holding an adequate reserve of pressure for stopping, the amount of train brake to balance the grade should not be more than approximately ¼ of the normal full service brake retarding force available.

2. On a grade, gravity acts on each ton of train weight with a force of 20 lb for each per cent grade as shown below:

Per Cent Grade	Down Grade Force of Gravity
1%	20 lb per ton
2%	40 lb per ton
3%	60 lb per ton

The brake retarding force required to balance the down grade gravitation force is the force of gravity less the car or train resistance. In the following examples, assume resistance is equal to approximately 4 lb per ton at speeds of 15 to 30 mph. Obviously, the heavier the car, the more brake retarding force is needed. However, the difference of a few tons in car weight requires considerably more braking. This is illustrated on the tabulation below and Figure 114. It is important for enginemen and trainmen to have an understanding of this.

FIG. 114 BALANCING A GRADE

Train With Cars of 80 Tons Average Weight

Descending Grade Per Cent	Gravity Force	Resistance Force*	Required Brake Retarding Force	Approximate Brake Pipe Reduction
1%	1600 lb	320 lb	1280 lb	6 psi
1½%	2400 lb	320 lb	2080 lb	8 psi
2%	3200 lb	320 lb	2880 lb	10 psi
2½%	4000 lb	320 lb	3680 lb	12 psi
3%	4800 lb	320 lb	4480 lb	14 psi

Train With Cars of 100 Tons Average Weight

Descending Grade Per Cent	Gravity Force	Resistance Force	Required Brake Retarding Force	Approximate Brake Pipe Reduction
1%	2000 lb	400 lb	1600 lb	7 psi
1½%	3000 lb	400 lb	2600 lb	10 psi
2%	4000 lb	400 lb	3600 lb	12 psi
2½%	5000 lb	400 lb	4600 lb	14 psi
3%	6000 lb	400 lb	5600 lb	16 psi

Note: If curvature is particularly heavy, train resistance will increase and somewhat less brake will be required.

3. While a difference of 2 psi in brake pipe reduction to balance the grade may not seem too significant, it means quite a bit in stopping ability on the grade. A normal stop on the grade should always be available with the service brake. However, balancing the grade has used up a portion of the service brake. Therefore, a service stop on the grade will be similar to a stop on level territory with a partial service application. For example, if descending a 2% grade with a train of 80-ton cars (80 tons per operative brake) employing a 10-psi reduction to balance and using 70-psi brake pipe pressure:
4. Components of the brake system including brake shoe and wheel have practical limits on the work they can be subjected to, or the braking horsepower they can dissipate. The practical limit is that which will give satisfactory performance of brake shoe and wheel down the complete grade with ample margin for stopping anywhere on the grade.

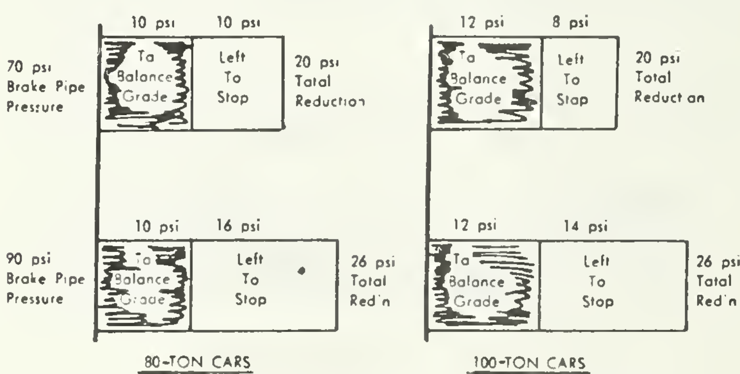


FIG. 116 EFFECT OF BRAKE PIPE PRESSURE ON GRADE BALANCING AND STOPPING

a. Braking horsepower varies directly with speed. For example, if a grade is descended at 30 mph instead of 15 mph, twice as much braking horsepower is required, even though the force of gravity on the train is the same.

b. The braking horsepower required varies directly with the weight of the train. An 8000-ton train takes twice as much braking horsepower as a 4000-ton train. If conditions permit, the lighter train can descend the grade at higher speed and still stay within practical limits of brake shoe and wheel performance. The braking horsepower required is provided by the combination of train air brake horsepower plus dynamic brake horsepower, if available (see section on dynamic brake for more complete information). If dynamic brake is available, it is obvious that the train air brakes do not have to be worked as hard. Higher speeds may be permitted under these conditions. In the opposite case, if dynamic is not available, it is only practical common sense to run under more conservative conditions at lower speeds.

c. Practical limits of continuous braking (work transferred from car brake shoes to car wheels) is in range of 20-25 hp for the 33-in. freight car wheel. Larger wheels can take somewhat more horsepower, generally in proportion to the square of the diameter. Brake shoes are capable of performing satisfactorily within these ranges; however, shoes will wear at a faster rate with higher braking horsepower demand.

d. The effect of high gross car weights on the braking demand per car wheel is important. For example, on a train of 73 cars each weighing 110 tons, or total of 8030 tons, there would be 584 car wheels, not including locomotive or caboose to share the train air brake work load. This might be compared with a train of 146 cars of 55 tons average gross weight totaling 8030 tons as above, but with 1168 wheels to share the train brake work load. Obviously, a greater work load is imposed on wheels and brake shoes with trains of fewer and heavier cars.

5. Cycling brake manipulation: In the event that neither dynamic brake nor pressure maintaining is available, it will be necessary to descend the grade, using cycling manipulation and retainers set up. It is assumed that the required grade balancing brake application is heavier than that obtained with a minimum 6-8 psi brake pipe reduction. At heavier reductions, the brake cylinder pressure even with retainers, may reduce due to minor leakage if on the grade for a considerable period of time. Since the leakage rate varies from car to car, with some cars having very little leakage, compensating for this simply by increasing the brake reduction from time to time, would result in some cars having little brake cylinder pressure and others very high pressure. The brake shoes and wheels on the "low leakage" or "tight" cars may have excessive heat and wear. Therefore, it has proven to be more practical to release and reapply the train brakes from time to time. Hence, the term "cycling" implies that the speed will vary within limits because brakes are alternately applied and released.

a. Cycling manipulation and use of retainers go hand in hand. Retainers should be set up on a sufficient number of cars so they will hold just about enough brake cylinder pressure to balance the grade.

b. General practice is to make the initial brake pipe reduction somewhat heavier than that required to balance the grade, probably 9-12 psi, which is sufficient to fill brake cylinder to 20 psi or more. Timing of the start of this application is important as the train goes over the crest of the grade. The initial application should be started at a point that will prevent speed from becoming excessive as the train moves onto the grade and before the application becomes effective on the whole train. There is no substitute for good judgment and experience. It is better to approach the crest of the grade at a somewhat lower speed than authorized for the train, making the initial application a little on the light side in order to get the feel of the train as it comes over the crest, and then add to it if the train

seems to require additional retardation. Hold the initial application so that the speed reduces under the average speed required. Then release the brakes. Retainers should hold the increase in speed during the release to a slow rate which will allow the brake valve handle to remain in release position at least 45 seconds and preferably longer.

c. Start the next application at a speed which will allow brakes to become fully effective before excessive speed is reached. However, since the brake system will not have had time to recharge completely, it will be necessary for the engineman to compensate for this in making the second and all succeeding reductions. Keep track of the brake pipe and equalizing reservoir gages during the release. When the next application is needed, note carefully the brake pipe pressure which may be less than equalizing reservoir (say 76 psi B.P., 80 psi ER). For the succeeding application, subtract the desired reduction from that existing brake pipe pressure and reduce the equalizing reservoir to this value (76—12=64 psi). Another method is to measure the equalizing reservoir pressure reduction from the moment the Service exhaust starts to blow. These methods will produce the desired brake pipe reductions. The cars in the train respond only to the actual (net) brake pipe and reservoir pressure changes effective at that point in the train.

d. Long periods of "short cycling" brake operation usually result in slight but steady lowering of minimum car reservoir pressures. Frequent observations of the train must be made while moving down grade. Pay particular attention to signs of excessive braking heating when using a cycling manipulation. Retainers will develop higher brake cylinder pressures on the head end than those toward the rear. Therefore, the head end cars will do considerably more braking work. Follow local rules in regard to cooling stops and train inspection. Follow local rules regarding stopping on grades. General good practice is to stop at a point where the locomotive independent brake will hold the train thus allowing the train brake system to be fully recharged.

J. Pressure Maintaining

With pressure maintaining, brake pipe pressure is maintained against brake pipe leakage to the level of the pressure in the equalizing reservoir. The normal or natural brake pipe gradient, or "taper" from front to rear will be maintained during service applications.

Pressure maintaining is a basic feature of the 26-L equipment and is an optional feature, although widely applied, on 24-RL. Train brake release action is faster and more positive with pressure maintaining.

f. Attention to the main reservoir pressure and load-unload cycle of the compressors will indicate the relative amount of air flow into the brake pipe, if the locomotive is not equipped with a brake pipe flow indicator. During pressure maintaining operation, if markedly increased air flow into brake pipe becomes evident, be alert for the following procedure:

1. Brake application being made from the rear end.
2. Bad leakage has developed in the brake pipe or hoses back in the train.

DYNAMIC BRAKE RETARDING FORCE
3300 HP DYNAMIC BRAKE

	6 motored axles		4 motored axles	
Speed mph	Extended Range Dynamic, lb	Standard Dynamic, lb	Extended Range Dynamic, lb	Standard Dynamic, lb
6	60,000	14,400	40,000	9,600
12	60,000	30,000	40,000	20,000
24	60,000	60,000	40,000	40,000
30	48,600	48,600	32,400	32,400
40	34,000	34,000	24,000	24,000
50	28,800	28,800	19,200	19,200
60	24,000	24,000	16,000	18,000
70	20,400	20,400	13,600	13,600

THE BRAKE PIPE FLOW INDICATOR

The brake pipe flow indicator, Fig. 90, is an instrument which indicates the rate of flow of air through the automatic brake valve to the brake pipe. It may be used with any of the brake equipment presently in use.

This instrument is actually a differential pressure gage which indicates on its dial a difference between two pressures. It also actuates a switch which lights a lamp as an added indication. The lamp switch may be set to light the indicating lamp at any desired reading.

The brake pipe flow indicator is the only indicator which the engineman has which will inform him as to what is taking place in the brake pipe in regard to air flow. In locomotive brake equipment, such as the No. 6 types and the 24-RL, the flow indicator has one of its connections piped to the feed valve pipe and the other connection piped to the brake pipe. In the 26-L equipment, these connections are made across a check valve and choke arrangement known as the A-19 flow indicator adapter, which is placed in the main reservoir pipe to the 26-C brake valve. With the No. 6 and 24-RL types of locomotive brake equipment, the flow indicator indicates the difference in pressure between the feed valve pipe or core and the brake pipe—the greater the differential, the greater the air flow. With 26-L equipment the flow indicator indicates the difference in pressure across the choke orifice in the A-19 flow indicator adapter, Fig. 90-A, and, here also, the greater the difference, the greater the air flow.

The brake pipe flow indicator, because it indicates the rate of flow of air to the brake pipe, may be used to indicate several things.

It can indicate when a train is charged. It can indicate when excessive leakage is present. The indicated reading is not an actual measure of brake pipe leakage, but represents the condition of air flow into the brake pipe. It can indicate when the brakes are being applied from the caboose, an occurrence which does not show on the locomotive brake pipe gage.

In cold weather, the flow indicator can be of assistance, as it can indicate whether difficulty in obtaining sufficient pressure on the rear or caboose is due to leakage, possible freeze-up, restriction in the locomotive brake pipe, or the first few cars of the train.

Referring to the illustration showing the brake pipe flow indicator, it will be noted that there are two pointers. One of these is colored black, and this pointer indicates the brake pipe air flow. The other pointer is colored red and may be set at any point; for example, it might be desirable to indicate a minimum flow at a certain time. To adjust the red hand, the adjusting knob in the center of the cover above the dial is turned. The indicator lamp is shown to the right of the adjusting knob. This lamp shows amber through the lens.

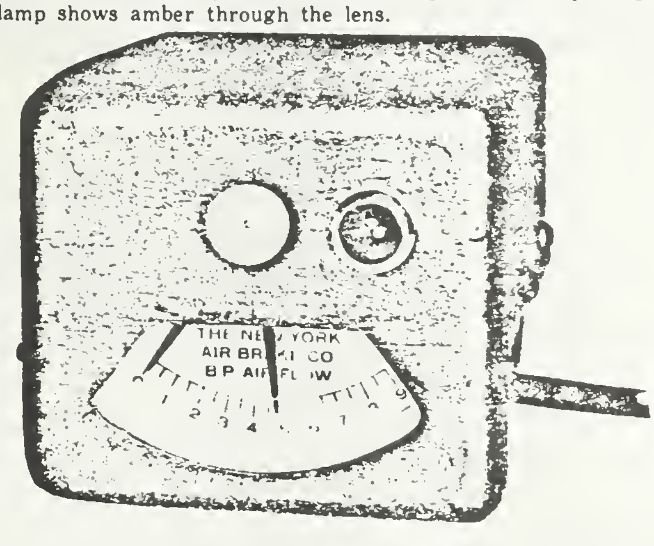


FIG. 90 TYPE B BRAKE PIPE FLOW INDICATOR

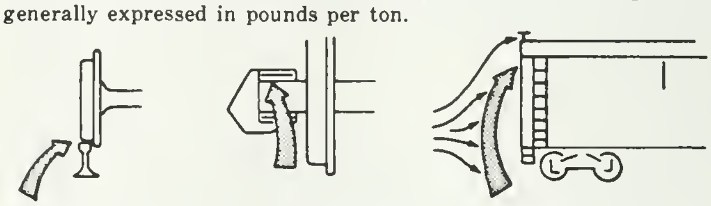
10. Applying Brakes From the Rear End

Conductor valves and back up valves are only for the purpose of stopping trains, and must not be used to apply train brakes in an attempt to control slack. Do not use these unnecessarily as they may cause a light service application from which stuck brakes may result, or may cause an undesired release of a locomotive initiated service application. After the train stops, close the caboose valve, moving the caboose valve handle to extreme left. The engineman should be alert for indications of brakes being applied from the rear, such as:

1. Increased air flow through the automatic brake valve into the brake pipe—Main reservoir gauge changing rapidly, compressors loading more frequently, etc.
2. If the locomotive is equipped with a "B" type flow indicator, the reading will increase rapidly and may light the indicator lamp.
3. Speed may reduce abnormally and amperage, if the locomotive is under power, may also increase.
4. When an application from the rear is detected, the engineman should make a minimum brake pipe reduction of 6 to 8 psi and wait until the brake pipe pressure "settles". Reduce power gradually, making further 2 to 3 psi brake pipe reductions if necessary, until the train stops. When about 200 ft. from the stopping point, open the sanders, close the throttle and apply the independent brake. Make final brake pipe reduction so the exhaust is blowing when train comes to rest.

ROLLING RESISTANCE

The rolling resistance of a train can be determined by formula, but more generally is taken from tables and curves based on formula. The most widely used of such formulae is the Davis Formula. Rolling resistance is generally expressed in pounds per ton.



Flange Resistance + Journal Resistance + Air Resistance = Total Rolling Resistance

Other things being equal, total rolling resistance, expressed in pounds per ton . . .

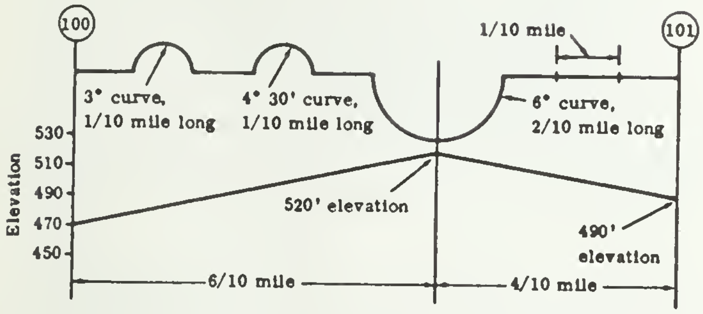
1. ...Increases as speeds increase
2. ...Decreases as car weights increase

ROLLING RESISTANCE
(Lb./Ton)

Speed	20 Ton Car	100 Ton Car
10 MPH	7.5	2.6
60 MPH	16.5	7.0

(Note, however, that when expressed in total pounds, the 100-ton car naturally offers more resistance than the 20-ton car.)

ALLOWANCE FOR CURVATURE



The method for adjusting gradient calculations to allow for the effect of the resistance added by track curvature can be illustrated with the above representation of a one-mile section of track chart and profile:

1. *Determination of gradient*

   From milepost 100 to location 100.6:

$$\frac{\text{Rise x } 100}{\text{Distance}} = \frac{(520 \text{ ft.} - 470 \text{ ft.}) \text{ x } 100}{6 \text{ mi. x } 5280 \text{ ft.}} = \frac{5000 \text{ ft.}}{3168 \text{ ft.}} = 1.58\%$$

2. *Determination of average curvature*

   From milepost 100 to location 100.6:

$$\text{Avg. curve} = \frac{(3^\circ \text{ x } .1 \text{ mi.}) + (4.5^\circ \text{ x } .1 \text{ mi.}) + (6 \text{ x } .1 \text{ mi.})}{.6 \text{ mi}} =$$

$$\frac{1.35^\circ \text{ mi}}{.6 \text{ mi}} = 2.25^\circ$$

3. *Determination of grade equivalent of 2.25° curve*

   Grade equivalent = 2.25° x 0.05 = .1125%

4. *Determination of effective grade*

   From milepost 100 to location 100.6:

   Effective grade = Actual Grade + Grade Equivalent = 1.58% + .1125% = 1.69%.

   (Descending, the effective grade = —1.58% + .1125% = —1.47%

DAVIS FORMULA for rolling resistances:

The rolling resistance of locomotives and cars is affected by so many variable factors (weight, speed, size, journal type, configuration, wind, temperature, etc.) that it can be accurately determined only by test. Obviously performance calculations must rely on something more practicable. The most widely known and universally accepted of the several formulae for calculating resistance of a given train is the one developed by W. J. Davis.

$$R = 1.3 + \frac{29}{W} + 0.045^{*}V + \frac{0.0005^{*}AV^2}{Wn}$$

where: R = resistance in lb/ton on level tangent track
W = weight per axle in tons
n = number of axles per car
A = cross section of car in square feet
V = speed in miles per hour

*Factors are for freight cars; other values are substituted for passenger cars and locomotives.

In the formula, the expression $1.3 + \frac{29}{W}$ represents journal resistance; $0.045V$ represents flange resistance; and $\frac{0.0005\,AV^2}{Wn}$ represents air resistance.

As an example, the rolling resistance (R) of a 40-ton (W=10, n=4) box car of 80 square feet cross section (A=80) at 10 mph (V=10) would be:

$$R = 1.3 + \frac{29}{10} + (0.045 \times 10) + \frac{(0.0005 \times 80 \times 10^2)}{(10 \times 4)} = 4.75 \text{ lb/ton}$$

CURVE RESISTANCE

Because the wheels of railroad rolling stock are fixed to, and therefore rotate with, their axles in rounding a curve there is a tendency for the wheel following the inside track to be skidded — or for the outside wheel to spin. Whether one or the other occurs or whether the tendency is overcome by lateral movement of the axle within its journals, friction (resistance) is created. The "sharper" the curve, the greater this resistance becomes.

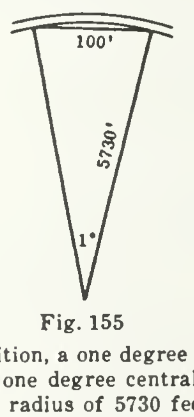


Fig. 155

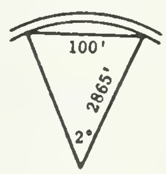


Fig. 156

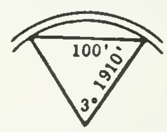


Fig. 157

By definition, a one degree curve is a curve, a 100 ft. chord of which determines a one degree central angle (Fig. 155). It happens that such a curve has a radius of 5730 feet. Given the degree of curvature, radius can be determined by dividing 5730 feet by the degree of curvature. Thus two and three degree curves (Figs. 156 & 157) have respective radii of $\frac{5730 \text{ ft.}}{2}$ and $\frac{5730 \text{ ft.}}{3}$, or 2865 and 1910 feet.

The effect of varying degrees of curvature on train resistance has been determined by test, and most simply stated, indicates that one degree of curvature offers the same resistance to train movement as a 0.05 percent grade, i.e., 1 pound/ton (0.05 x 20) for each degree of curvature.

APPENDIX G

EXCERPTS FROM AIR BRAKE RULES OF OTHER U.S. RAILROADS

Baltimore and Ohio Railroad Company (Chessie System)

D. Operation of Coal Trains—Seventeen Mile Grade— Reduce power to permit the train to pass the summit of the grade just east of the overhead bridge at Altamont at a speed approximately eight miles per hour. As soon as train speed starts to increase, an initial reduction of eight pounds brake pipe pressure will be made and dynamic brake applied. Further reductions of the brake pipe and modulation of the dynamic brake will be used to control speed between 20 and 25 miles per hour, between Altamont and Piedmont.

If the amount of the brake pipe reduction is in excess of fifteen pounds approaching Swanton Flats, the train will be brought to a stop, air brakes inspected and sufficient handbrakes applied before descending the remainder of the grade. The brake pipe must be completely recharged before moving.

At no time will the train be pulled with air brakes applied for a distance greater than 2 miles, or if the brake pipe reduction is greater than 20 pounds.

Before detaching power at Keyser, reduce equalizing reservoir pressure to 80 pounds and comply with CDT-30, Rule 219-C to reduce pressure in air brake system in freight cars.

Coal trains must not exceed 25 miles per hour between Altamont and Piedmont.

E. Operation of Solid Loaded Grain Trains—All solid loaded grain trains must increase to 100 lbs. brake pipe pressure at Hardman and carry to Cumberland Terminal.

Grain trains descending 17 Mile Grade which do not respond to service braking in a normal manner will be stopped between Swanton Road Crossing and Mile Post 219, east of Swanton. After stopping, sufficient hand brakes will be applied to hold the train on the grade. Train will be recharged, then proceed with hand brakes applied. During the remainder of the descent if it becomes necessary to reduce brake pipe pressure more than 25 lbs., stop will be made and brake pipe recharged before further movement.

Denver and Rio Grande Western Railroad Company

Special Time-Table Rules

AIR BRAKE AND RETAINER OPERATION, CAR LIMITS AND INSPECTION STOPS

4. Freight trains will be considered "Bulk" trains if average weight per car is more than 80 actual tons and, in addition, the actual tonnage per road loco. unit with operative dynamic brake exceeds:

GP-9, SD-7, SD-9	600 tons
GP-30, GP-35, GP-40	1000 tons
SD-40, SD-45	1300 tons
Utah Ry 300 Series	600 tons
Utah Ry 400 Series	1200 tons

These trains must not be operated in excess of 40 MPH.

4-A. On "Bulk" trains (see Rule 4) in territories shown below:

Crater to Bond	Monarch Spur
Winter Park to Fraser	Fir to LaVeta
East Portal to Leyden	Sunnyside to M P 6
Tennessee Pass to Minturn	Kyune to Helper
Leadville Branch	Soldier Summit to Thistle

if dynamic brake is inoperative or if use of full dynamic brake and 18 pound brake pipe reduction will not control train at the allowable speed, train must be stopped, retainers on all loads placed in operative position and sufficient hand brakes set to prevent movement. Train must not proceed except as instructed by Chief Dispatcher or other proper authority.

Crater to Bond, Winter Park to Fraser and East Portal to Leyden

4-C. On freight trains if actual tonnage per unit with operative dynamic brake exceeds:

GP-9	1400 tons
GP-30, GP-35, GP-40	2000 tons
SD-7, SD-9, SD-40, SD-45	3000 tons

beginning at head end of train use ten retainers plus one retainer for each additional 50 tons. If dynamic brake is inoperative retainers will be used on all cars.

Tennessee Pass to Minturn

4-D. On freight trains if actual tonnage per unit with operative dynamic brake exceeds:

GP-9	1000 tons
GP-30, GP-35, GP-40	1500 tons
SD-7, SD-9, SD-40, SD-45	2000 tons

beginning at head end of train use ten retainers plus one retainer for each additional 50 tons. If dynamic brake is inoperative retainers will be used on all cars.

Burlington Northern

MOUNTAIN GRADE OPERATION GENERAL RULES

440 A. Mountain Grade Territory is defined as grades of one and eight tenths (1.8) percent or greater.

B. The control of train speed is a key factor in mountain grade operation since the amount of braking required varies directly with speed. Speed can get out of control in a very short time on heavy grades. An EMERGENCY brake application should be made WITHOUT HESITATION should any condition occur where there is doubt of ability to control train speed.

C. The brake pipe pressure maintaining feature must be used when locomotive is so equipped.

D. Train speed must be effectively controlled with no more than a 15 psi brake pipe reduction except as covered under Rule 441 B 5.

E. The train must be observed frequently for any indication of overheated wheels.

F. Before passing summit of heavy descending grades, trainmen on freight trains must note by observation of the caboose gauge that the brake pipe pressure is not less than 75 psi or 85 psi if 100 psi brake pipe being carried. If the pressure is not within this limit, the train must be stopped and the cause of the abnormal condition corrected before proceeding.

G. The speed of passenger trains when passing the summit must not exceed the maximum speed authorized for the descending mountain grade. If a stop is not made by use of train brakes at or closely in advance of the summit, a running brake test, as prescribed by Rule 225 A, must be made before passing the summit.

H. When passing the summit, the speed of freight trains must not exceed the maximum speed authorized for the descending mountain grade. Where helper locomotives are used the engineer of the lead locomotive will be responsible for the method of helper operation as related to train handling.

I. When available, the dynamic brake must be used.

J. In event of failure of dynamic brake, or for any other reason when train speed cannot be properly controlled, engineer must take prompt action to stop the train using an EMERGENCY brake application if necessary and before proceeding take corrective action to permit safe operation of the train.

K. If all locomotives become inoperative on a descending grade, stop must be made immediately. Train and/or locomotive must be secured with hand brakes until condition causing failure has been corrected.

MOUNTAIN GRADE OPERATION TRAIN BRAKING REQUIREMENTS

441 A. Supervisors, dispatchers, locomotive engineers and conductors must consider the status of each train as related to: operative dynamic brake, tons per operative brake and maintaining type brake valves. Requirements contained in the applicable category must then be complied with while descending mountain grades.

B. Trains of 100 Tons or More Per Operative Brake:

1. Locomotives having dynamic brake in effective operating condition must be used on both lead and helper locomotives.
2. Lead locomotive must be equipped with a brake pipe pressure maintaining feature in operative condition.
3. Standard brake pipe pressure will be 100 psi.
4. Not less than a minimum brake pipe reduction (5 to 7 psi) must be used in conjunction with dynamic brakes.
5. Train speed must be effectively controlled with no more than a 18 psi brake pipe reduction.
6. Normally not less than the number of locomotives required on the ascending grade must be used on the descending grade to control speed.
7. Speed must not exceed 30 MPH on the descending grade.
8. AN EMERGENCY BRAKE APPLICATION SHOULD BE MADE WITHOUT HESTIATION SHOULD ANY CONDITION OCCUR WHERE THERE IS DOUBT OF ABILITY TO CONTROL TRAIN SPEED.

C. Trains of 80 to 99 Tons Per Operative Brake:

1. Locomotives having dynamic brake in effective operation condition must be used.
2. Lead locomotive must be equipped with a brake pressure maintaining feature in operative condition.
3. Standard brake pipe pressure will be 90 psi.
4. Not less than a minimum brake pipe reduction (5 to 7 psi) must be used in conjunction with dynamic brakes.
5. Train speed must be controlled with no more than a 15 psi brake pipe reduction.
6. Normally not less than the number of locomotives required on the ascending grade must be used on the descending grade to control speed.
7. AN EMERGENCY BRAKE APPLICATION SHOULD BE MADE WITHOUT HESITATION SHOULD ANY CONDITIONS OCCUR WHERE THERE IS DOUBT OF ABILITY TO CONTROL TRAIN SPEED.

Burlington Northern (Cont.)

D. Trains of Less than 80 Tons Per Operative Brake:

1. Locomotives having dynamic brakes and/or brake pipe pressure maintaining feature in operative condition must be used.

2. Not less than a minimum brake pipe reduction (5 to 7 psi) must be used in conjunction with dynamic brake unless the developed retardation will cause the train to stop.

3. Standard brake pipe pressure will be 90 psi.

4. Train speed must be controlled with not more than a 15 psi brake pipe reduction.

5. AN EMERGENCY BRAKE APPLICATION SHOULD BE MADE WITHOUT HESITATION SHOULD ANY CONDITION OCCUR WHERE THERE IS DOUBT OF ABILITY TO CONTROL TRAIN SPEED.

Trains of Less than 80 Tons Per Operative Brake With Neither Dynamic Brake Nor the Brake Pipe Pressure Maintaining Feature Available.

1. Standard brake pipe pressure will be 90 psi.

2. Train speed must be effectively controlled with not more than 15 psi brake pipe reduction.

3. When required, retaining valves must be set up.

4. The cycle method of braking normally must be used.

5. AN EMERGENCY BRAKE APPLICATION SHOULD BE MADE WITHOUT HESITATION SHOULD ANY CONDITION OCCUR WHERE THERE IS DOUBT OF ABILITY TO CONTROL TRAIN SPEED.

F. Use of Retaining Valves

1. Unless otherwise specified, the use of retaining valves will not be required on trains operated in compliance with Paragraphs B, C, D or E of this Rule or when requested by Engineer.

2. Unless otherwise specified, when train speed cannot be controlled in accordance with brake pipe reduction limitations specified by engineer, retaining valves will be required as follows:

a. Stop must be made immediately and the required number of retainers and/or hand brakes set.

Southern Pacific Transportation Company

Grade Air Brake Test

RULE 25. Summit.

At locations designated by the Timetable, trains must stop before passing summit of grade. An application of brakes must be made to determine that brakes are operative throughout the train and have applied on rear car.

RULE 25-A. Running Test.

At locations designated by the Timetable, running tests must be made as follows:

Head end crew must inform rear end crew that a running test of train air brakes is to be made. After acknowledgment that running test is to be made, engineer must apply brakes with sufficient force to insure air brakes are operating properly. Brake pipe pressure, as indicated by gauge at rear of train, must be observed prior to, and immediately after, the brake pipe reduction to give assurance that a brake pipe reduction was made. It must be known that brakes on rear car of train apply. When the brake pipe pressure is being restored, as indicated by gauge at rear of train, and brakes are released on rear car, trainmen must inform engineer that the running test is complete. If radio communication is not distinct, train must be stopped with the automatic air brakes and comply with Rule 25.

E. Balancing the Grade.

Operating freight trains on descending grades involves:

1. Balancing the grade, or holding speed steady at safe and practical values.

The amount of brake (train) retarding force used to balance the grade normally should not exceed one half (50 percent) of the normal full service train brake available if dynamic brake and pressure maintaining are operative.

In order to hold speed steady on a descending grade, the force of gravity must be balanced by the sum of train resistance and brake retarding force. The heavier the grade, the lower the effect of train resistance; and the more brake must be used. Train resistance will vary with the type of cars, train make-up, and train length and weather. On heavier grades the majority of the grade retarding force comes from the dynamic brake and the train air brake.

2. Maintaining ample safety margin, or keeping speed to a value which will allow stopping the train anywhere on the grade within signal spacing or other prescribed limitations.

a. The braking horsepower required varies directly with the weight of the train. The braking horsepower required is provided by the combination of train air brake horsepower plus dynamic brake horsepower. If dynamic brake is available, the train air brakes do not have to be worked as hard. In the opposite case, if dynamic is not available, train must operate at lower speeds.

Southern Pacific Transportation Company (Cont.)

b. The term "cycle braking" implies that the speed will vary within limits because brakea are alternately applied and released.

It is assumed that the required grade balance brake application is heavier than that obtained with a minimum six to eight psi brake pipe reduction. With heavier reductions the brake cylinder pressure, even with retainers, may reduce due to minor leakage if on the grade for a considerable period of time. Since the leakage rate varies from car to car, with some cars having very little leakage, compensating for this simply by increasing the brake reduction from time to time, would result in some cars having little brake cylinder pressure and others very high pressure. The brake shoes and wheels on the "low leakage" or "tight" cars may have excessive heat and wear.

(1) Cycle braking without retaining valves and without dynamic braking: Use light brake pipe reductions consistent with speed and tonnage of the train. The engine brake may be used to assist in the control of slack, using care to prevent excessive wheel heat.

(3) With retaining valves and without dynamic braking compliance with Rule 17 is required. Make the minimum brake pipe reduction increasing with additional light reductions as required to balance the grade, probably 10-12 psi, which is sufficient to fill brake cylinder to 20 psi or more. Timing of the start of this application is important as the train goes over crest of the grade.

The initial application should be started at a point that will prevent speed from becoming excessive as the train moves onto the grade and before the application becomea effective on the whole train.

Hold initial application so that the speed reduces under the average speed, desired or required, then release the brakes. Retainers should hold the increase in speed, during the release, to a slow rate which will allow the brake valve handle to remain in RELEASE position until just prior to the time required to reapply brakes to preclude exceeding authorized speed.

Start the next application at a speed which will allow brakes to become fully effective before excessive speed is reached. However, since the brake system will not have had time to recharge completely, it will be necessary for the engineer to compensate for this in making the second and all succeeding reductions. The brake pipe and equalizing reservoir pressures must be observed just before the release. At the time for next application, or succeeding applications, the equalizing reservoir must

d. General:

The brake pipe flow indicator provides an indication that a train separation haa occurred or the conductor's valve has been opened. This is indicated by the hand moving to the right, generally a sound of air flowing and illumination of the amber light on the flow indicator.

On heavy grades speed can get out of control in a very short time. If use of emergency is indicated, don't hesitate. Service applications usually react too slowly and allow too much speed increase while they are becoming effective.

Even if the addition of 10 psi more brake pipe reduction would eventually balance the grade, at the higher speed, the brake horsepower may be high enough to be excessive for a long grade. Both brake shoes and wheels will probably be overworked.

Again, if dynamic is lost or becomes ineffective for any reason on a heavy grade:

(1) Get the train stopped quickly.

(2) Use emergency application, if required.

(3) Follow safe practice and local rules before again proceeding after such an unplanned stop on the grade.

APPENDIX H

DATA ON TIE CARS IN EXTRA 3119 WEST

Non-revenue No.	Old No.	Lightweight		
909447	15414	79,300*(1)	33"	6x11 Friction
913037	15372	78,600		
913044	15323	79,700		
913017	15400	78,900		
909448	15340	79,700		
913038	15326	79,300		
913029	15376	78,800		
913021	15408	78,300		
913030	15376	78,800		
913046	15341	79,600		
913035	15335	78,600		
913012	15356	80,200		
913013	15357	79,500		
913018	15344	79,300		
913027	15404	79,600		
913008	15382	79,500		
913003	15417	79,100		
913041	15370	78,600		
913026	15375	79,000		
913031	15330	78,800		
Caboose		58,000*(2)		

TOTAL WT. 1,641,200#

1,641,200# - 2000#/ton = 820.6 tons

*Approximation

(1) 909447 lightweight shown is average of
909445 - 78800#
909448 - 79300#
909449 - 79700#

237,800 ÷ 3 = 79266#

(2) Nominal lt. wt. 29 ton = 58000#

F - 70 - 1

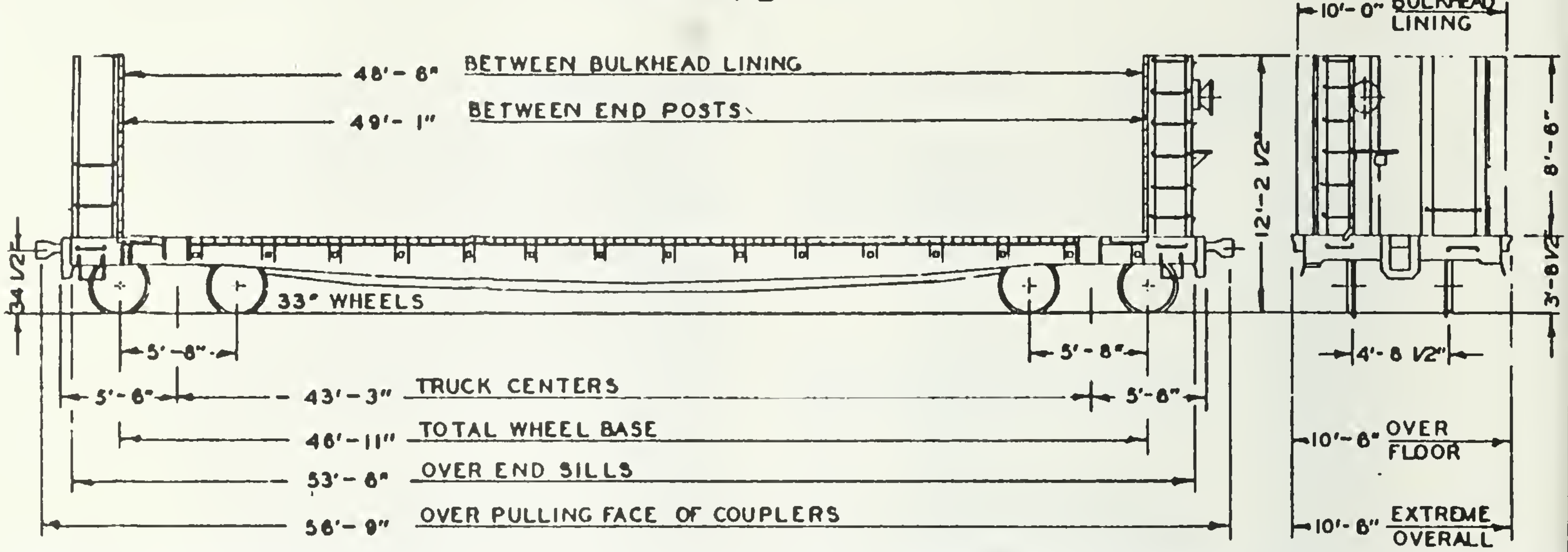
CLASS F-70-1

FLAT CAR

152000 LBS. CAPACITY

FB

CAR NO'S 15320-15424



LENGTH - BETWEEN BULKHEAD LINING	48'-6"
WIDTH - OVER FLOOR	10'-6"
HEIGHT - RAIL TO TOP OF FLOOR	3'-8 1/2"
WT. OF EACH TRUCK A-3	8000 LBS.
LT. WT. OF CAR COMPLETE	67300 LBS.
UNDERFRAME - CAST STEEL - AVERAGE WT. 34980 LBS.	GEN STL.
BULKHEAD - CAST STEEL	" "

CAR BUILDER	NO. CARS BUILT	YEAR BUILT
OMAHA	105	1956

MIN. CURVE NEGOTIABILITY COUPLED TO BASE CAR 204 FT. RAD.

GENERAL DESIGN	244-C-12753
BRAKE ARRGT.	154-C-12742
TRUCK ARRGT.	423-C-12767
UNDERFRAME ARRGT.	444-C-12757
ALLOCATION OF SPEC.	282-C-12763
PAINT. LETT. & NUM.	303-C-12769
8'-6" CAST STL. BULKH'D	298-C-14266

AIR BRAKES - AB	WABCO
AXLES - 6" x 11"	BETH.
ANGLE COCK HOLDER	RY. DEVICES
BRAKE BEAMS - NO. 18 UNIT	BUFFALO
" CYL. PUSH ROD	SCHAEFER
" LEVER CONN.	"
" ROD JAWS & EYES	"
" PIPE ANCHORS	GUSTIN-BACON
" REGULATOR	UNIVERSAL
" " -AUTO.-	AMER. S.A.B.
" SHOES	ABSCO
COUPLER - TYPE E	ASF
" CENTERING DEV.	SREMCO
" RELEASE RIGGING	"
" YOKES - VERTICAL -	OMA STL WKS
CYL. & FLOATING LEVERS	SHOP MADE
DEFECT CARD HOLDER	WEST RY EQ
DRAFT GEAR FR-16	W.H. MINER
" KEY RETAINER	ILL RY EQ
HAND BRAKE -	NATL. BR. EQUIP. CO.

JOURNAL BEARING	MAGNUS
" " WEDGE	SHOP MADE
" BOX LID	SYM. WAYNE
" " LUBRICATORS	AAR APPROVED
LADING ANCHORS - A-30	WINE RY. APP.
SPRINGS - 2 1/2" TRAVEL	AMER. LOCO.
TRUCK BOLSTER	ASF
" SIDE FRAME	"
" STABILIZER	"
" LEVERS	SCHAEFER
" SIDE BEARINGS	STUCKI
UNDERFRAME -	GEN. STL.
UNIT SIDE FRAME WEAR PLT.	FLANNERY
WHEELS - CAST STL. AAR X-3	GRIFFIN
BULKHEAD	GEN STL.

PLASTERBOARD LOADING

8'-6" BULKHEAD

UNION PACIFIC RAILROAD CO.
RESEARCH AND
MECHANICAL STANDARDS

9-1-75	5-4-73	5-4-76	DATE	DIAGRAM F-7-24
C	B	A	ISSUE	DRAWN 7-1-60

APPENDIX I

UNION PACIFIC RAILROAD TEST DATA

WHEELS FROM KELSO WORK TRAIN

SPECIMEN NUMBER	1*	2	3*	4	5*	6*	7*	8	x 9	10	11 x	12 x	x 13	14* x	15 x	16 x	17 x	18 x	19 x	20 x	21 x	22* x	23*
Tread & Flange	1	0	2	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3
Front Fillet	0	0	1	0	4	2	2	0	0	0	2	0	0	2	0	0	0	0	0	2	0	1	0
Back Fillet	0	0	1	0	4	2	2	0	0	0	0	0	0	2	0	0	0	0	0	2	0	1	0
Back Rim	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Severity Index	.25	0	1.0	0	2.0	1.25	1.75	0	0	0	.5	0	0	1.0	0	0	0	0	0	1.5	0	1.25	.75
Phys. Comments	BC	C	AB	BC	B	AB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPECIMEN NUMBER	24*	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39*	40*	41	42	43	44	45	46*
Tread & Flange	2	0	0	1	1	0	0	0	0	0	3	1	1	1	0	2	0	3	1	0	0	0	0
Front Fillet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4
Back Fillet	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	2	0	2	2	0	0	3
Back Rim	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Severity Index	.5	0	0	.25	.75	0	0	0	0	0	.75	.25	.25	.25	1.0	.5	.5	.75	.75	.5	0	0	1.75
Phys. Comments	-	-	-	A	A	-	-	-	-	-	-	A	A	A	-	A	-	-	-	-	C	-	-
SPECIMEN NUMBER	47	48	49	50	51	52*	53*	54*	55*	56	57	58	59	60	61	62	63*	64*	65*	66	67	68	69
Tread & Flange	0	0	0	0	0	3	2	3	0	0	0	3	1	1	1	0	2	3	2	1	0	0	2
Front Fillet	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Back Fillet	0	0	3	0	0	3	0	0	4	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Back Rim	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Severity Index	0	0	1.75	0	0	2.25	.5	.75	1.0	0	0	.75	.25	.25	.25	0	.5	.75	1.25	.75	0	0	.5
Phys. Comments	-	-	-	-	-	-	-	-	-	-	-	-	A	A	AB	-	A	B	A	A	-	A	-
SPECIMEN NUMBER	70*	x 71*	x 72	73*	74	75*	76*	77	78	79	80*	81*	82	83	84	85	86	87	88	89	90	91	92
Tread & Flange	2	0	0	2	2	3	2	0	0	0	3	2											
Front Fillet	0	0	0	0	0	0	0	0	0	0	0	0											
Back Fillet	4	3	0	0	2	0	0	0	0	0	0	0											
Back Rim	0	3	0	0	0	0	0	0	0	0	0	0											
Severity Index	1.5	1.5	0	.5	1.0	.75	.5	0	0	0	.75	.5											
Phys. Comments	A	-	-	B	-	B	B	-	-	A	-	B											

Rusted/Corroded Surfaces

0 - Shows no thermal evidence worthy of noting.
1 - Straw to dark straw discoloration or indications of 400°-700°F.
2 - Light blue to blue/purple discoloration or indications of 750°-900°F.
3 - Dark blue to grey/black discoloration or indications of 950°-1000°F.
4 - Evidence of surface decarburization at temperature over 1050°F.
A - Tread shows evidence of rotational skidding or skipping.
B - Thermal evidence apparent on one wheel only.
C - Wheel assembly shows physical damage or breakage.

* Held inside of Laboratory.

x - Roller-bearing wheelset from VAN train

Union Pacific R.R. Brake Efficiency Test Data

Date 11-24-80 Car # 913020 Cyl. Size 10"X12"

Location OMAHA SHOPS Class F-70-1 Shoe CAST-IRON

Tested by: RAC, MRH, RY Lt. Wt. 80,000 G.R.L. 220,000

Comments: Hand Brake

Bell Crank

Sheave Whl.

Brake Cyl. Pressure —P.S.I.—	Location								
	R 1	L 1	R 2	L 2	R 3	L 3	R4	L 4	Total
Hand Brake	2970	3010	2865	3050	2965	2925	3085	2915	
Hand Brake Tapped	3430	3430	3280	3425	3430	3390	3615	3475	
10	535	585	535	550	355	340	390	365	
15	940	1005	955	985	740	710	785	710	
20	1250	1325	1270	1310	1185	1140	1250	1115	
35	2340	2435	2390	2445	2380	2335	2460	2250	
50	3330	3555	3440	3610	3580	3525	3710	3440	
64	4270	4710	4475	4705	4500	4435	4600	4335	36035
Repeat 20	1285	1410	1350	1410	1340	1260	1410	1255	
Tapped 20	1555	1565	1430	1575	1405	1425	1475	1445	
Repeat 50	3505	3865	3695	3925	3580	3600	3700	3325	29195
Tapped 50	4100	4200	3975	4210	3960	3930	4195	4035	32605
Empty Load 50									
Empty Load Tapped 50									

Hand Brake Ratio G.R.L.— Tapped

Brake Ratio G.R.L. at 50 P.S.I. Tapped 14.8

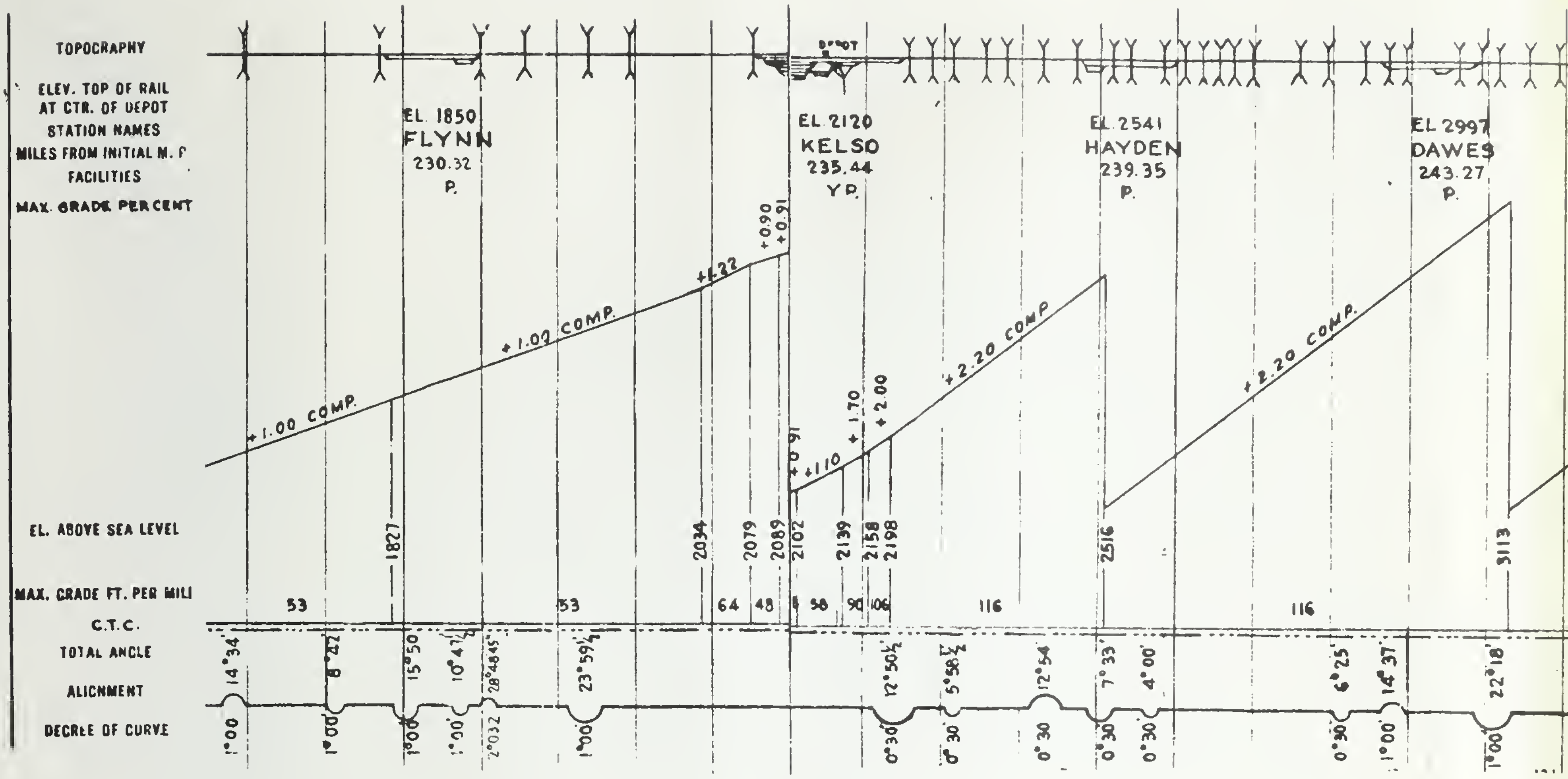
Brake Ratio G.R.L. at 20 P.S.I. Tapped

ake Ratio Lt. Wt. at 50 P.S.I. Tapped 40.75

Theor. Brake Force at 50 P.S.I.

Efficiency at 50 P.S.I. Tapped 86.5

Empty/Load % at 50 PSI Tapped


TOPOGRAPHY
ELEV. TOP OF RAIL AT CTR. OF DEPOT
STATION NAMES
MILES FROM INITIAL M. P.
FACILITIES
MAX. GRADE PERCENT
EL. ABOVE SEA LEVEL
MAX. GRADE FT. PER MILE
C.T.C.
TOTAL ANGLE
ALIGNMENT
DEGREE OF CURVE
EL. 1850
FLYNN
230.32
P.
EL. 2120
KELSO
235.44
YP.
EL. 2541
HAYDEN
239.35
P.
EL. 2997
DAWES
243.27
P.
DEPOT
+1.00 COMP.
+1.00 COMP.
+1.22
+0.90
+0.91
+0.91
+1.10
+1.70
+2.00
+2.20 COMP.
+2.20 COMP.
1827
2034
2079
2089
2102
2139
2158
2198
2516
3113
53
53
64
48
58
90
106
116
116
14°34'
8°42'
15°50'
10°47'
28°48'45"
23°59'
12°50'
5°58'
12°54'
7°33'
4°00'
6°25'
14°37'
22°18'
1°00'
1°00'
1°00'
1°00'
2°032
1°00'
0°30'
0°30'
0°30'
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0°30'
0°30'
1°00'
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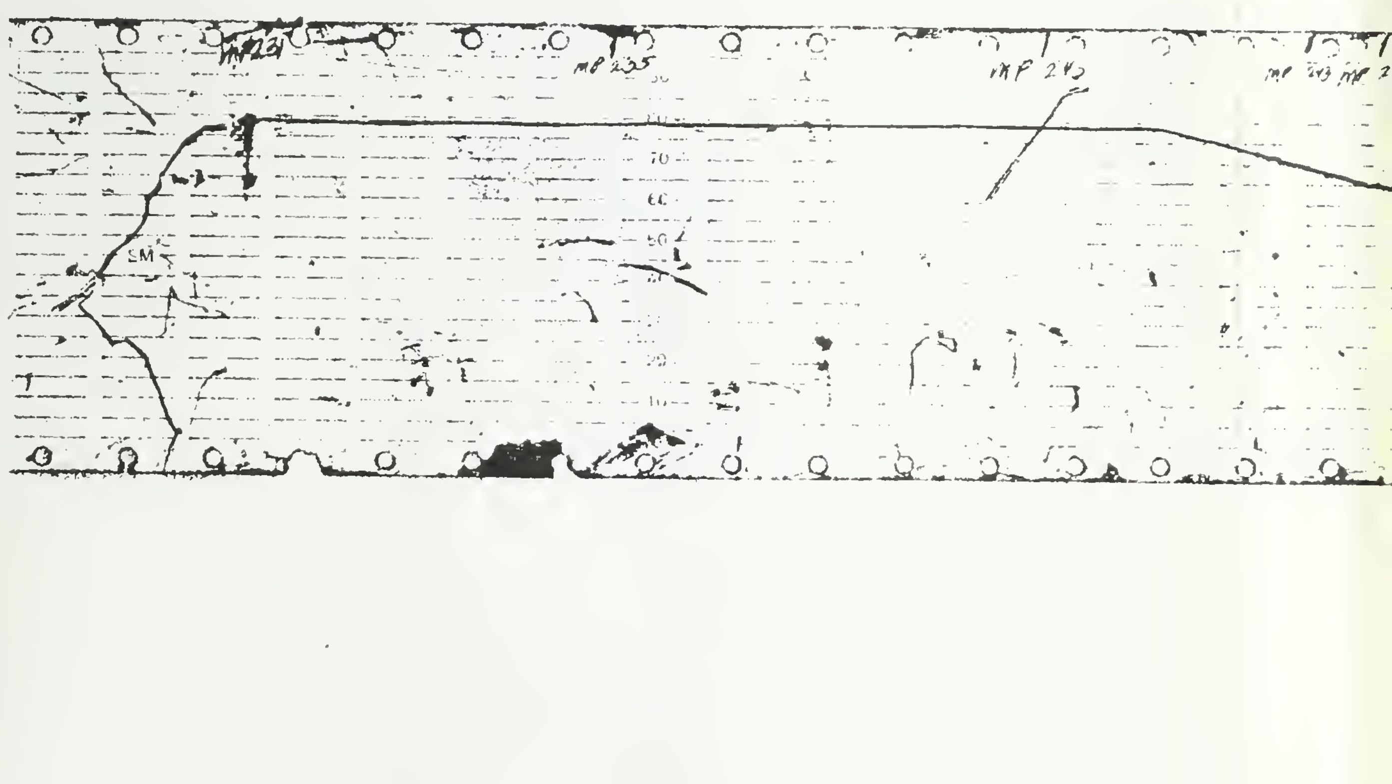
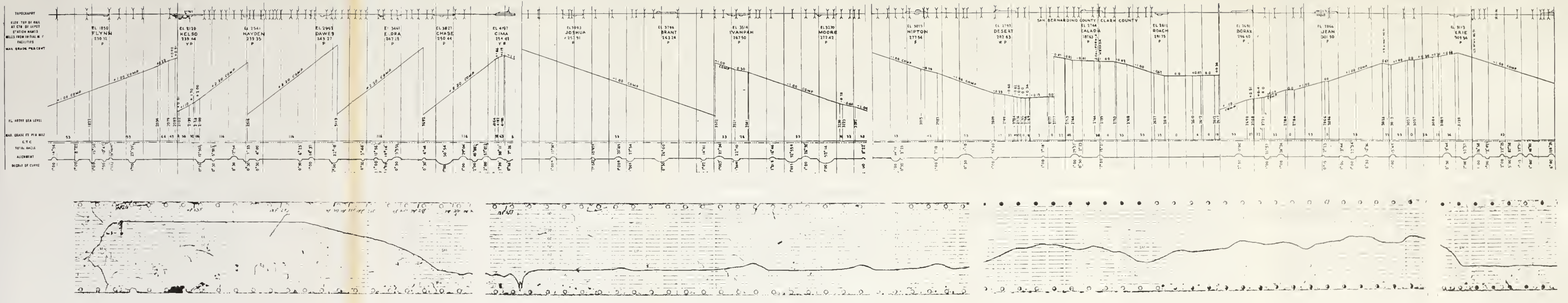

MP 231
MP 235
MP 240
70
60
50
SM

APPENDIX J. SPEED TAPE OF EXTRA 3119 WEST FROM ERIE TO KELSO AND ACCIDENT LOCATION, ALIGNED WITH CONDENSED PROFILE.



NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT OF SOUTHERN PACIFIC TRANSPORTATION COMPANY FREIGHT TRAIN EXTRA 9164 WEST SURF, CALIFORNIA MAY 22, 1981

NTSB-RAR-81-8

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes
The subject report was distributed to NTSB mailing lists: 8A, 8D and 14A.

16. Abstract
At 4 a.m., P.d.t., on May 22, 1981, 39 cars of Southern Pacific Transportation Company's (SP) westbound Extra 9164 derailed at Surf, California, while moving successively through a 2° curve, a short length of tangent track, and a 1° curve on a 1-percent descending grade. The derailing cars struck and derailed 20 cars of eastbound SP Extra 8874, which was standing on a side track south of the main track, and the locomotive, 3 cars, and the caboose of SP Lompoc Local Extra 1507, which was standing on a side track north of the main track. One employee was injured seriously, and 13 other employees and 3 transients were treated and released at either the local community hospital or a local Air Force hospital for inhalation of plaster dust and of gas formed from residual hydrogen fluoride in an empty tank car. Damage was estimated at $1,552,522.

The National Transportation Safety Board determines that the probable cause of this accident was the derailment of the trailing truck of the 53d car from the locomotive, an empty boxcar, at the entrance spiral to a 1° right curve because of hunting and wheel climb due to track/train dynamics. The derailed car continued on the track structure for about 1,100 feet until it struck a track frog in a crossover. The trailing truck then became detached from the car body and the following 38 cars derailed, striking cars standing on adjacent tracks. Contributing to the cause of the accident was the overspeed movement of the train.

17. Key Words Derailment; hunting; computer simulation; hazardous materials; corrosive; 112A 400W tank car; brake beam; side frame; truck; track frog.	18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*

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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: September 15, 1981

DERAILMENT OF SOUTHERN PACIFIC TRANSPORTATION COMPANY FREIGHT TRAIN EXTRA 9164 WEST AT SURF, CALIFORNIA, ON MAY 22, 1981

SYNOPSIS

At 4 a.m., p.d.t., on May 22, 1981, 39 cars of Southern Pacific Transportation Company's (SP) westbound Extra 9164 derailed at Surf, California, while moving successively through a 2° curve, a short length of tangent track, and a 1° curve on a 1-percent descending grade. The derailing cars struck and derailed 20 cars of eastbound SP Extra 8874, which was standing on a side track south of the main track, and the locomotive, 3 cars, and the caboose of SP Lompoc Local Extra 1507, which was standing on a side track north of the main track. One employee was injured seriously, and 13 other employees and 3 transients were treated and released at hospitals for inhalation of plaster dust and of gas formed from residual hydrogen fluoride in an empty tank car. Damage was estimated at $1,552,522.

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INVESTIGATION

The Accident

At 9:30 p.m., P.d.t., on May 21, 1981, Southern Pacific Transportation Company (SP) train No. 01WCOAY21, Extra 9164 West, 1/ with 3 locomotive units, 11 loaded cars, and 120 empty cars (including the caboose), left West Colton, California, en route to Oakland, California, after a satisfactory airbrake test. The engineer, fireman, and head brakeman were on the locomotive and the conductor and flagman were on the caboose. The engineer operated the train for 107.8 miles to Santa Barbara, California. The train stopped at Santa Susana, California, without incident, and a locomotive unit, which was to be moved dead-in-tow, was placed in the train following the third working unit.

1/ SP trains operate north and south geographically between Los Angeles and Oakland, California, but timetable direction is east and west, respectively. Therefore, for purposes of this report, the land side (east) of the tracks will be referred to as north and the ocean side (west) as south.

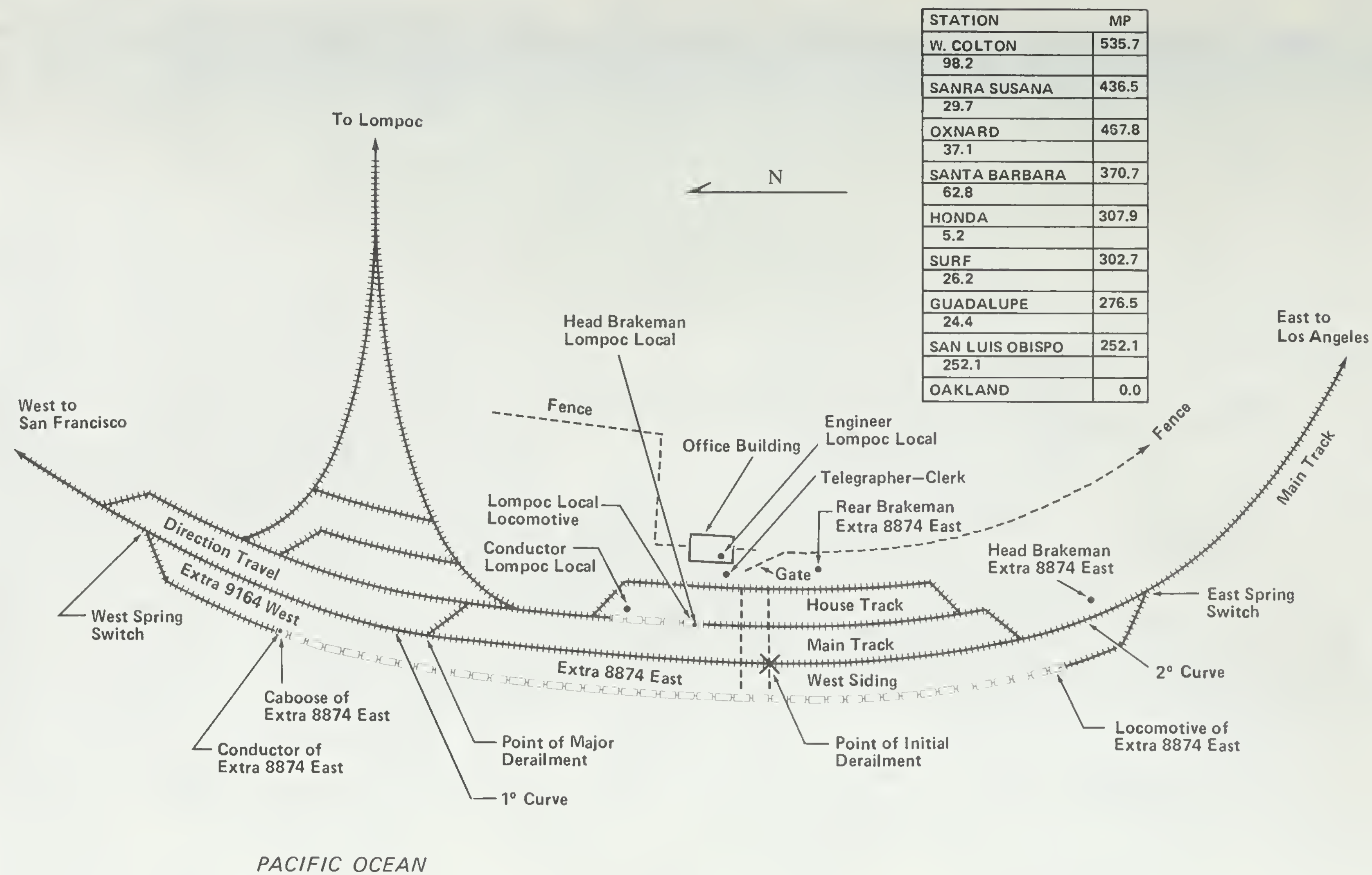
At Oxnard, California, the engineer slowed the train to 30 mph as required by a slow order. When the 30-mph speed was reached, a running brake release was made. The fireman stated that he felt a slight forward surge of the train after which the brakes were applied in an undesired emergency application. When the stopped train was inspected, a broken knuckle in a coupler assembly was found about 30 cars from the caboose and replaced, and the train continued westward. The head brakeman joined the conductor and flagman on the caboose after the knuckle was replaced.

The fireman, who was also qualified through training and examination as an engineer, began operating the train at Santa Barbara. The train reached the summit of a 0.8-percent grade about 2 miles west of Honda, California, and 3.2 miles east of Surf, California. As the train passed over the crest of the grade, the fireman progressively reduced the throttle setting. The fireman estimated that the train was traveling about 55 mph with the throttle in position run 2 as it passed through Surf. Because of the undesired emergency brake application at Oxnard, the engineer and fireman decided that the airbrakes would be used only if necessary, and the airbrakes had not been used after leaving Oxnard. Therefore, as the train descended a 1-percent grade through Surf, neither the dynamic brakes nor the airbrakes were used. About 4 a.m., when approximately one-half of the train had moved past the SP train order office building at Surf, cars began to derail and the train's brakes applied in emergency. The initial derailment occurred about 50 feet east of the train order office, but the major derailment occurred near a crossover about 1,100 feet west of the office. (See figure 1).

Thirty-nine cars derailed from Extra 9164 West. The derailing cars struck and derailed 20 cars from SP Extra 8874 East, which was standing in a side track south of the main track, and 3 cars, a caboose, and the locomotive of SP Lompoc local Extra 1507, which was standing on a side track north of the main track. (See figure 2.) The 53d car, an empty boxcar, was the first car found to be derailed following the accident. The rear truck (A end) had become detached from the east end of the car during the derailment. The east end of the boxcar had moved southward and had been dragged about 600 feet west of the crossover that connected the main line and the house track. The No. 4 brake beam was missing from the truck. A brake beam found adjacent to the house track mainline crossover where the major derailment occurred was identified by SP mechanical personnel as the No. 4 brake beam of the rear truck of the 53d car.

The R-3 wheel on the rear truck of the 53d car had a deep gash in the flange indicating that it had struck a sharp, rigid object. The front truck of the 54th car was derailed but the trailing truck of that car was not derailed. Wheel flange marks were found on the center sill of the 54th car, which may have derailed at the same time that the 53d car derailed. The remaining derailed cars were jackknifed or stacked between the house track and the siding south of the main track, east of the crossover.

Three crewmembers of Extra 8874 East had watched Extra 9164 West as it passed. The head brakeman, who was standing on the north side of the main track about 2,300 feet east of the railroad office at Surf, said that he inspected the entire train as it rolled past him and that he neither saw nor heard anything unusual. He said that after approximately 100 cars of the train passed him, the train's brakes applied in emergency and that the caboose came to a stop about 5 car lengths west of him. About that time, he heard airbrakes apply again on a train, and he saw that the red mars light (an oscillating red headlight) on the locomotive of Extra 8874 East was illuminated, indicating that an emergency brake application had occurred on the train. Also at that time, he observed that Extra 8874 East lurched back about 30 feet. The rear brakeman of Extra 8874 East, who was standing on the north side of the main track about 200 feet east of the office, also did not observe anything unusual as the train passed, until he saw sparks coming from



STATION	MP
W. COLTON	535.7
98.2	
SANRA SUSANA	436.5
29.7	
OXNARD	467.8
37.1	
SANTA BARBARA	370.7
62.8	
HONDA	307.9
5.2	
SURF	302.7
26.2	
GUADALUPE	276.5
24.4	
SAN LUIS OBISPO	252.1
252.1	
OAKLAND	0.0

Derailment Southern Pacific Transportation Company Train
01WCOAY21 at Surf, California on May 22, 1981

No Scale

Figure 1.--Plan view of accident site.

Figure 2.—Accident site.

the car wheels of about 20 cars as a result of applied brakes and then saw cars derailing. As the head cars of Extra 9164 West started past the caboose of Extra 8874 East, the conductor in the caboose heard the brakes of Extra 9164 West apply in emergency. He said that the train separated and about 30 cars (his estimate) continued past the caboose for about 3,000 feet to the point where the locomotive stopped.

Three crewmembers of the Lompoc local also watched Extra 9164 West as it passed. The conductor was on the north side of his train near its locomotive. He saw nothing unusual until, after an estimated 30 cars passed him and he was about 175 feet west of the office, he saw "sparks, dust and rocks shooting" from Extra 9164 West. At that time, he also saw the freight cars start to lean. The engineer of the Lompoc local was watching from the train order office window as Extra 9164 West passed. He began to hear a metal-to-metal grinding sound, and he ran about 10 feet to the front door to examine the train more closely. At that time he saw sparks coming from under the moving train. He turned back into the office, ran out the rear door, and moved eastward about 25 feet to the edge of the office building, from where he saw cars derailing and moving toward the office building. The head brakeman of the Lompoc local, who was in the locomotive cab, heard noises caused by the derailment and left the cab of the locomotive to escape from the derailing cars.

When Extra 9164 West actuated the approach annunciator to Surf, the telegrapher-clerk in the train order office went outside to inspect the train as it passed. He said that after about one-third of the train passed him, he saw an unusually heavy sparking of the wheels. He estimated that about six cars passed with the sparks and a "flame" coming from under the cars. He said that the sparks generally were coming from the area of the car wheels, but that the "flame" seemed to be coming from under the opposite side of the cars. He said that rocks or pieces of metal were becoming airborne from 40 to 50 feet east of the cffice and striking the office building and breaking windows. He ran into the office and while looking back he heard metal-to-metal grinding noises. He continued through the office and out the back entrance.

None of the persons who observed the passing train saw anything unusual until particles became airborne or they saw sparks coming from beneath the train. No one saw the first car or cars derail.

During the derailment, an "empty" DOT 112A 400W tank car, which had last contained hydrogen fluoride, struck the locomotive of the Lompoc local, and a gash about 36 inches long was cut in the side of the tank. Because of the gash, gas from an unknown residual amount of hydrogen fluoride in the tank car, under approximately 16 psi (at 70° F), escaped and formed a gas cloud. None of the crewmembers or three transients, reported to have been riding on Extra 9164 West, was seriously injured by the escaping gas.

Injuries to Persons

Injuries	Extra 9164 West	Extra 1507	Extra 8874 East	Others	Total
Fatal	0	0	0	0	0
Nonfatal	4	4	4	5	17
None	1	0	1	0	2
Total	5	4	5	5	19

Damage

Sixty-three freight cars, a caboose, and a single locomotive unit were derailed in the accident. Twenty-five cars from Extra 9164 West, five cars from Extra 8874 East, and four cars from the Lompoc local were destroyed. The locomotive of the Lompoc local was derailed and slightly damaged. About 3,000 feet of track was destroyed. Damage costs were estimated to be:

Equipment	$1,144,800
Track	114,000
Lading	256,722
Wreck clearing	37,000
	$1,552,522

Crewmember Information

The engineer and fireman of Extra 9164 West had attended the SP engineer training school at El Cerritos, California. All of the train crewmembers and the telegrapher-clerk were current on SP operating rules and were qualified for their respective positions in accordance with SP requirements. (See appendix B.)

Train Information

The locomotive of Extra 9164 West consisted of units SSW 9164, SP 9213, and UP 3734. Units 9164 and 9213 were model SD-45-2 manufactured by the Electro Motive Division (EMD) of the General Motors Corporation. Unit 3734 was an EMD model SD-40-2 and unit 8990, the dead-in-tow-unit, was an EMD model SD-45. The locomotive weighed 1,626,000 pounds including the dead-in-tow unit. The locomotive units were equipped with operable radios, a 26-L airbrake system, and a speed indicator, but did not have a speed recorder, alertness device, or deadman control device. The caboose also was equipped with an operable radio.

The 131-car train was 7,484 feet long excluding the three-unit locomotive and had a trailing tonnage of 5,485 tons. The train was arranged so that the head 57 cars were empty cars with an approximate total weight of 2,000 tons. The next 34 cars, including the derailed cars, weighed about 1,891 tons, with 4 cars having an average weight of about 130 tons each. The trailing 40 cars weighed 1,481 tons. Eight tank cars--seven empty and one containing oil--were among the cars that derailed. Also derailed were six cars over 73 feet long and one car 35 feet long or less. The 71st car from the locomotive was restricted to 45 mph because at speeds greater than 45 mph, a car of that type was subject to hunting. 2/

The DOT 112A 400W tank car that leaked the hydrogen fluoride was the 78th car in the train. The car and its contents were being shipped by Allied Chemical Corporation.

Method of Operation

Trains are operated through the accident site by timetable, train orders, and the signal indications of an automatic block signal system. The maximum allowable speed for

2/ Hunting is an oscillatory lateral movement of the trucks that develops at certain speeds and which can induce wheel climb. Data is available to show that empty boxcars and certain types of other cars will hunt within a particular speed range. Worn side frames, worn wheel contours, and worn rail conditions contribute to hunting.

freight trains is 55 mph. There are six dragging or derailing equipment detectors and four hot box detectors between Oxnard and Surf. The last of these, a hot box detector and a dragging equipment detector, are located 9.8 miles east of Surf. None of the detectors was actuated between Oxnard and Surf by Extra 9164 West. The train order office at Surf was equipped with an operable radio.

Southern Pacific operating rules require crews of standing trains and telegrapher-clerks to observe passing trains for defects that might be dangerous. According to SP operating rule No. 829, when possible these individuals are supposed to stand on the ground at a safe location for this rollby inspection. (See appendix C.) When defects are observed, traincrews are alerted by radio and/or signals.

A computer terminal is provided in each open train order office. The telegrapher-clerk will forward a train consist to the next office ahead when the train passes his office. The consist printout displays a symbol for identifying cars containing hazardous materials. A train containing hazardous materials has the letter "K" included in its designation symbol. For example, Extra 9164 West would have been identified as 01WCOA K 21 if it had contained loaded cars of hazardous materials. The symbol indicates the train is the first unit from West Colton to Oakland, and that it contained hazardous materials. The "21" indicates that the train originated at West Colton on May 21, 1981. In the actual designation of Extra 9164 West as 01WCOA Y 21, the Y indicated mixed freight.

Upon inquiry, the computer will identify "K" trains. A printout of the consist will provide a commodity classification code for the commodity, such as "FG" for flammable gas, and a Standard Transportation Commodity Code (STCC), a seven-digit number beginning with 49. When the STCC number is used, the computer will print out pertinent information about the commodity, such as what it is and how it is to be handled. On the morning of May 21, 1981, the computer system was shut down for routine maintenance and a printout was not immediately available for the guidance of emergency forces that responded to this accident.

Before they depart the terminal, the traincrews and enginecrews are provided with a written consist list which gives the order of cars in the train, their initials and numbers, their lading, and their destination. The list also shows the locomotive numbers, the train tonnage, and the train length. Loaded hazardous materials cars are identified on the consist.

Uniform Freight Classification Tariff Rule 35, Section 7, permits not more than 3 percent by weight or up to 1/3 of the quantity shown on billing documents for the last revenue-paying shipment of a tank car's contents to be left in the car when it is unloaded. This procedure maintains pressurization so that contaminants will not enter the car. The tariff is used to describe the classification of freight on which transportation charges will be based. The shipper determines whether the car is offered to the carrier as an "empty" or a "load." Freight charges usually are not imposed for "empty" cars moving under Rule 35, Section 7.

Title 49 CFR 174.25(c) requires that unless a waybill accompanies an "empty" tank car identifying the last contents of the car, the information must be shown on the consist or wheel report. In addition, 49 CFR 172 requires that an "empty" tank car placard be applied to "empty" tank cars that last contained hazardous materials unless all previous contents have been cleaned out of the car. Current "communication" regulations in 49 CFR 172 for "empty" tank cars provide for the top 1/3 of DOT tank car placards to be covered by a black triangle with the word "empty." Regulations require the class name to appear in the midsection of the placard. When the top 1/3 of the placard is covered with

the "empty" triangle, it obscures the class pictograph on the "empty" placard. Title 49 CFR 173 requires that cars transporting hydrogen fluoride be marked with the commodity name in 4-inch-high letters on the sides of the car. The 112A 400W tank car was marked and placarded as required by regulations. The car came to rest against the locomotive of the Lompoc local with the end placard and markings visible from south of the yard office.

However, in some instances, "empty" tank cars that last contained hazardous or corrosive materials are identified on a consist as "dangerous." The conductor of Extra 8874 East said that the consist of Extra 9164 West did not provide adequate information about hazardous materials cars and empty tank cars to enable their being quickly identified. About June 1, 1981, the SP initiated a new format at certain terminals that includes more information on hazardous materials cars, whether loaded or empty. The SP said that the new format will be expanded as soon as possible to cover the entire system.

The International Association of Fire Chiefs (IAFC) has petitioned the Materials Transportation Bureau (MTB) of the U.S. Department of Transportation (DOT) for the removal of all references to "empty" placards in 49 CFR Parts 172 and 174 because the IAFC believes the placards are misleading. The DOT has issued an Advance Notice of Proposed Rulemaking (Docket HM-180) regarding such placards.

The crews also are provided with a train profile printout which shows the individual car weights in sequential order, and for each five cars the weight and length is given as a cumulative value. Information also is given to identify long, short, high/wide, and slow-speed cars. The restricted speed car, the 71st car on Extra 9164 West, was identified on the train profile printout by an asterisk, but the asterisk was smudged and indistinct, and the crews overlooked the restricted speed car.

Track Information

The railroad at Surf consists of a single-track main line with a 6,220-foot passing track on the south side, and a small switching yard ranging from two to three tracks on the north side. The track on the north side adjacent to the main line, identified as the house track, is about 4,546 feet long. The house track enters the main line at the west end of Surf, 171 feet west of the switch to the pass track. It enters the main line on the east end about 1,200 feet east of the office building in the 2° curve. A crossover, which contained a track frog, extends between the house track and the main line about 1,100 feet west of the office building. (See figure 1.) A narrow, private, black-topped grade crossing was about 50 feet east of the Surf office building. The office building is located about milepost 302.7. The zero milepost is at San Francisco, California, and mileposts increase by timetable direction sequentially from west to east.

The track through Surf is built of a mixture of 113-, 132-, and 136-pound, continuous-welded rail laid on timber crossties on a crushed-stone ballast. No exceptions were taken to the track or roadway by Safety Board investigators.

As Surf is approached from the east, the track extends through a 270-foot transition curve, a 634-foot, 2° curve to the right, and a 270-foot exit transition curve. Then the track is tangent for about 710 feet and then extends through a 200-foot transition curve, a 1,134-foot, 1° curve to the right, and a 200-foot exit transition curve. The grade is 1-percent descending westward.

Meteorological Information

The weather at Surf about 4 a.m. on May 22, 1981, was clear with a light breeze blowing from the ocean and good visibility. The temperature was about 60° F.

Medical and Pathological Information

The brakeman on the caboose of the Lompoc local received a skull fracture, broken ribs, cuts, bruises, and abrasions. The conductor of the Lompoc local received back injuries and inhalation injuries from the gas and dust. The brakeman on the caboose of Extra 9164 West broke a bone in his right foot. The engineer of the Lompoc local received bruises, and the head brakeman suffered from gas and dust inhalation. Other employees were given a general examination and released from hospitals.

Survival Aspects

The locomotive of the Lompoc local was struck by a derailing tank car, but the cab was not crushed. The head brakeman was not injured when the impact occurred. The caboose of the Lompoc local was overridden by derailing cars and crushed, but the rear brakeman was able to get out of the caboose without help even though he was injured.

The gas cloud caused by the hydrogen fluoride released from the punctured tank car, combined with the dust from a bagged plaster compound that spilled from some wrecked cars, irritated eyes and caused breathing difficulty. The hydrogen fluoride that spilled onto the ground was neutralized by the plaster compound, which was mostly lime. The gas and dust cloud only covered a small area immediately around the train order office, and it dissipated in several hours.

Several train crewmembers, in their efforts to flee the area, ran into a chainlink fence that surrounded the office and extended east and west along the land side of the tracks. The head brakeman of the Lompoc local scaled the fence with difficulty by climbing over a locked gate just east of the office building. Other train crewmembers finally found an opening in the fence near the office through which they escaped the area.

After the derailment, an unidentified motorist gave four of the SP employees involved in the accident a ride to the 13th Street gate of nearby Vandenberg Air Force Base, from where they were then taken to the base hospital for examination. Rescue vehicles from Vandenberg AFB transported other crewmembers and transients to either the base hospital or the hospital in Lompoc.

The disaster response team from Vandenberg AFB was alerted when the train crewmembers arrived at the base gate and reported the accident at about 4:15 a.m., and the team was dispatched to Surf where they arrived at about 4:30 a.m. The team immediately established a command post and assumed control of the situation. The team ordered an evacuation of all railroad personnel and established a roadblock to prevent other persons from entering the area. The team was instrumental in identifying the cause of the gas cloud and the contents of tank cars involved in the derailment by working through the conductor of Extra 8874 East with the SP operating department. The team remained in charge until the SP hazardous materials team arrived about 8:30 a.m. from San Francisco. The SP hazardous materials team neutralized the hydrogen fluoride by mixing a 15:1 ratio of lime and water and forcing it into the tank car opening. Breathing apparatus were not available for the SP traincrews or the telegrapher-clerk. The disaster response team was equipped with breathing apparatus.

Tests and Research

The 53d car was built in 1959 and reconditioned during 1975. The last periodic inspection to satisfy Federal Railroad Administration (FRA) regulations was made in May 1979.

On June 3, 1981, the truck from the "A" end of the 53d car was inspected and tested at the SP mechanical facility at Roseville, California. The truck was a National C-1 Roller Bearing with hangerless-type brake beams. (See figure 3.) The matching truck sides were cast in June 1962 and the truck bolster in June 1959. The roller bearing adapters were gauged and were within acceptable tolerances. The roller bearing cups showed damage at R-3, L-3, and L-4 which occurred in the derailment.

Clearances between bolster gibs 3/ was measured to be:

Location	Top (inches)	Bottom (inches)
L-4	9 9/16	9 7/8
L-3	9 1/2	9 7/8
R-4	9 5/8	10 3/16
R-3	9 5/8	9 7/8

The clearance of a new bolster is a nominal 9 5/8 inches.

The truck side frame dimension that interfaced with the bolster gibs was measured and found to be:

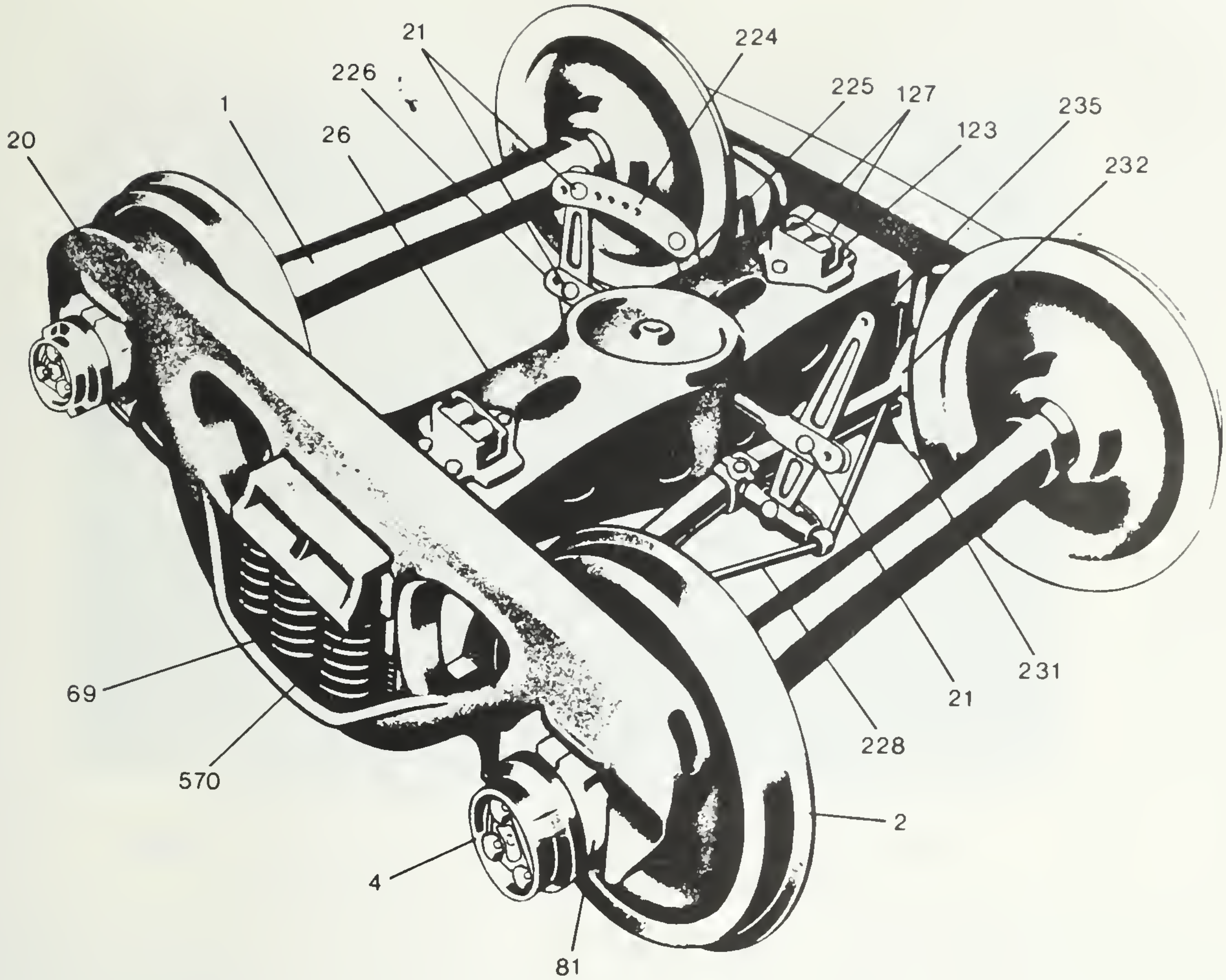
Location	Top (inches)	Bottom (inches)
L-4	8 1/2	9
L-3	8 1/8	8 11/16
R-4	8 3/8	8 5/8
R-3	8 1/8	8 3/16

A new side frame at this measurement point measures a nominal 9 inches. A mark on the side frame at the point this measurement was made showed evidence of a heavy strike that was received during the derailment. A maximum total clearance of 1 3/4 inch occurred between the bolster and side frame of this truck at the bottom R-4 location. Nominal clearance between the bolster and side frame is 7/8 inch.

For the test, a replacement brake beam was placed in the truck in the No. 4 position. The car springs were removed and blocks inserted in the side frames to lower the bolster to its normal, empty-car position. An air jack was placed between the side frames and pressure was applied. (See figure 4.) The brake beam did not drop out. As the pressure increased on the side frames, the roller bearing adapter caught on the edge of the roller bearing at the end of the axle. This barrier kept the side frames from moving farther apart. As the force was increased, the bottoms of the side frames began to spread, and it was concluded that the frames would "pop" out and the brake beam would drop out. The consensus of those present representing the Safety Board, the FRA, the SP, and the State of California Public Utilities Commission was that a spread of this magnitude would have occurred only if the truck were derailed. Force was applied to the truck while it was under the jack pressure to "parallelogram" the truck assembly, but the brake beam still did not drop out.

The "R" end of the brake beam that was believed to have come out of the "A" truck of the 53d car had been cut off with an oxygen-acetylene torch after the derailment. The

3/ Small projections at each end of the truck bolster that provide vertical guidance for the bolster and lateral restraints to the side frames when assembled as a truck.



STABILIZED TRUCK, ROLLER BEARINGS, BODY MOUNTED AIR BRAKE EQUIPMENT

PART NO.	DESCRIPTION	PART NO.	DESCRIPTION
1	CAR AXLE	127	SIDE BEARING ROLLER
2	CAR WHEEL	224	BRAKE DEAD LEVER GUIDE
4	TRUCK JOURNAL ROLLER BEARING	225	BRAKE LEVER BRACKET
20	TRUCK SIDE FRAME	226	BRAKE BOTTOM CONNECTION
21	BRAKE PIN	228	BRAKE BEAM COMPLETE
26	TRUCK BOLSTER	231	BRAKE SHOE
69	TRUCK SPRING	232	BRAKE SHOE KEY
81	ROLLER BEARING WEDGE	235	BRAKE LEVER
123	TRUCK SIDE BEARING CAGE	570	TRUCK FRICTION WEDGE

Figure 3.—Freight truck similar to the truck from the "A" end of the 53d car.

Figure 4.—Air jack in place shown forcing side frames apart on the "A" end truck of the 53d car.

"L" end had the lower half of the brake head missing. The tension member had been pulled loose at the point at which it was welded to the compression member. (See figure 5.) The weld did not break as the tension member was pulled loose. The tension member had a slight bend toward the rear of the car near the strut member. The unit end extension was rotated nearly 180° and the metal was severely distorted from heat. It was apparent that it had been affected by a great amount of heat generated from an undetermined cause. There were no wheel flange marks on the brake beam and only light scuffmarks.

The SP performed several computer simulations on the performance of Extra 9164 West through the accident area. Safety Board investigators participated in these simulations. The results of the simulations substantiated the enginecrew's account of their operation of the train. However, the speed at which the train was traveling when the emergency brake application occurred was determined by the computer simulation to have been about 60 mph in contrast to the 55 mph estimated by the enginecrew. The simulation, which was believed to duplicate more nearly the conditions prevalent and the manner in which the train was being operated, did not indicate the development of excessive compressive or tensile forces on either the 51st, 52d, or 53d cars of the train in the area of the Surf train order office. As shown by the computer, the maximum compressive forces that developed in the train while it was being operated without brakes and in throttle position run 2 were between -10,000 to -20,000 pounds of force. After the emergency brake application became effective, high compressive forces of around -100,000 pounds were developed in the train near the heavy loads, but not in the part of the train containing the 53d car. The heavy loads were in the vicinity of the east switch of the house track when the high compressive forces were developed.

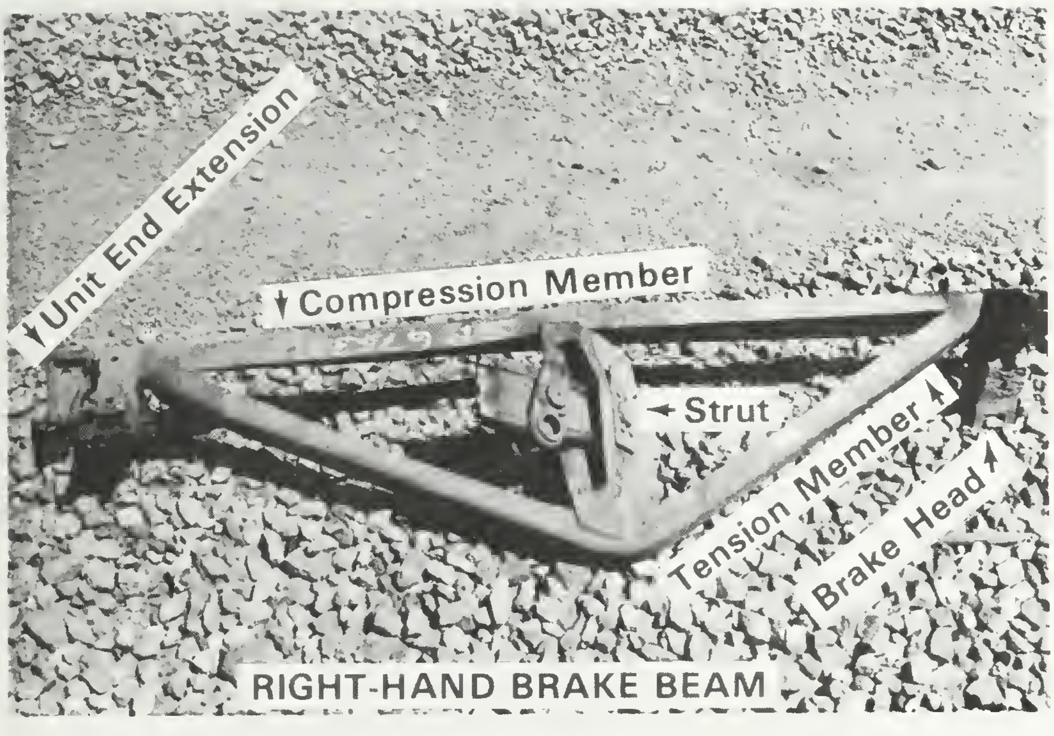


Figure 5.—Damaged brake beam identified as being the No. 4 brake beam from the 53d car (top) and an undamaged brake beam (bottom).

Compressive forces below -100,000 pounds are generally insufficient to cause a "liftout" of a car. The lateral to vertical forces (L/V ratio) were also insignificant in the simulation run. An L/V ratio approaching 1 is the theoretical value for a "liftout." The L/V ratio in the simulation run that most nearly matched the train handling reported by the engineer was less than 0.05 for the 51st, 52d, and 53d cars.

Several other simulations were made, but the method of operating the train was varied. One simulation assumed making a 6-pound brakepipe reduction with the throttle in position run 2. The results indicated some compressive forces as high as -300,000 pounds in that part of the train containing the heavy cars. Another simulation assumed that the throttle was left in position run 8 as the train crested the grade west of Honda. When the train's speed reached 60 mph, a 6-pound brakepipe reduction was made and maintained until the speed of the train was reduced to 50 mph, and then it was released. The train regained a speed of 60 mph as the train passed through Surf. The emergency brake application was made at the same place as previously done, but again, no high compressive forces were indicated near the 53d car.

The computer simulation was not programmed to consider wear on side frames. The program is also unable to simulate the effect of car hunting, or the actual condition of the track. The roadway design curvature, when taken into account, has little overall effect on the indicated speed of the train. Since the computer printout is made at 1-second intervals, it does not reproduce the behavior of the train continually. Therefore, the L/V ratio is given as a static, instantaneous value.

ANALYSIS

The Derailment

Crewmembers of the standing trains and the telegrapher-clerk were making the rollby inspection required by the operating rules as Extra 9164 West passed through Surf. The head brakeman of Extra 8874 East did not observe anything unusual about the train as it passed through the 2° right curve more than 2,300 feet east of the office building, which indicates that there was no dragging or derailed equipment at that point. The rear brakeman of Extra 8874 East did not see any evidence of dragging equipment or of any cars being derailed from where he was inspecting the train, about 200 feet east of the office building. This again indicates a no-fault status of the train at that point. The first indication of a problem with Extra 9164 West was when the rear brakeman of Extra 8874 East saw heavy sparking resulting from a brake application. The telegrapher-clerk's first indication that something was wrong was the loose ballast gravel flying past him at the office, and the engineer of the Lompoc local first noticed that something was wrong when he heard a metal-to-metal grinding noise coming from Extra 9164 West as it passed the office. This indicates that the first problem with the train occurred just east of the office. The conductor of the Lompoc local was about 175 feet west of the office when he became aware of "sparks, dust, and rocks shooting" from the direction of the moving train. Up to that time there had been no derailment. From the time the engineer of the Lompoc local, who was in the office, heard the grinding noise, he had sufficient time to run from the window to the front door from where he saw sparks coming from under the train. He had time to run to the back of the building before he saw cars derailing, which indicates that at least 10 to 12 seconds elapsed from the time the problem began until the actual derailment of cars. In the 10 to 12 seconds, a car that derailed at the grade crossing 50 feet east of the office, traveling about 60 mph, would have moved 1,100 feet to the crossover west of the office before the following cars would derail.

The evidence indicated that the 53d car was the first to derail, which is consistent with the noises heard and the flying debris seen by the telegrapher-clerk and the

crewmembers of the Lompoc local after much of the train had passed. The noise and "flames" probably were caused by the car's derailed wheels or truck side frames rubbing against the rails. It is possible that the front truck of the 54th car may have derailed along with the rear truck of the 53d car, and the wheels rubbing its center sill may have contributed to the sparks and "flames" reported. The severe cut found in the R-3 wheel flange upon inspection probably occurred when the wheel struck the wing of the track frog in the crossover leading from the house track to the main line 1,100 feet west of the office. Upon impact with the track frog, the 53d car could have bounced and separated from its truck, causing the following cars to derail and pile up. When the train separated, the train line was vented when the air hoses were pulled apart, and the airbrakes applied in emergency. The fact that the trailing truck of the car following the 53d car was not derailed tends to eliminate a rail turnover between the office and the crossover until after the general pile-up. It also supports the probability that cars following the 53d car did not derail until they piled up behind the derailed cars at the crossover. No wheel marks were found on the rail head in the area of the grade crossing. However, an empty car, especially if it were hunting, might jump or roll lightly over the ball of the rail without leaving a mark.

Statements made by the witnesses indicate that the pile-up of cars progressed from the crossover to the rear of the train instead of forward of the point of the major derailment, as cars normally do. This indicates that the excursion of the cars from the main track began near the crossover and was followed by an emergency brake application. The presence of the cars in the two tracks on either side of the main line caused the pile-up to progress toward the rear of the train from the point of the initial derailment, in a derailing pattern similar to one that would occur at a location where the roadbed runs through a cut area.

The manufacturer of the truck side frames had virtually no reports of a brake beam dropping out except where the brake beam was severely bent. The No. 4 brake beam of the 53d car was found separated from the "A" truck after the derailment. It is unlikely that a brake beam will drop out of a truck side frame unless the truck is derailed. Although the measured wear on the truck components of the 53d car suggested that excessive lateral movement allowed by the wear would permit the brake beam to fall, tests conducted at Roseville showed that this was highly improbable with a roller bearing wheel assembly. Furthermore, the tests showed that the increased clearances of the gibs caused by wear did not seem to materially affect the loss of the brake beam. Therefore, the Safety Board concludes that the brake beam dropped out after the 53d car initially derailed at the grade crossing.

The brake beam had been overheated from an undetermined cause. There was evidence that the bottom rod connecting the Nos. 3 and 4 brake beams on the "A" truck had been rubbing against an opening in the car bolster. However, because the bottom rod extended through the bolster, the downward travel of the brake beam would have been limited. If the brake beam had been dragging for some length of time, an alarm should have been given by one of the dragging equipment detectors, but none, including the one 9.8 miles east of Surf, was actuated. Also, it is possible that the hot box detector at the same location or one passed earlier might have been activated if the brake beam had been abnormally hot at that point. The emergency stop made by Extra 9164 West at Oxnard could have caused damage to the brake beam, but there is no evidence to support this possibility. The compression member, which could have had an old fracture or could have been fractured at Oxnard, was not deformed from its normal alignment except for the twisted brake head and unit end extension. The deformation of the brake beam could not have occurred while the brake beam was cold because there was no evidence of brittle breakage or cracking. Therefore, it seems unlikely that the brake beam was bent between Los Angeles and Oxnard and seems likely that it was overheated and bent at a point west

of Oxnard. Additionally, there was no trouble observed or reported on Extra 9164 West before it arrived at Oxnard. Because of the lack of evidence that the brake beam was down, and as a result of the tests conducted at Roseville, the Safety Board concludes that the brake beam did not cause the derailment.

Car hunting also could have caused the derailment. The wear of the truck side frames and the car bolster of the 53d car could have been caused by hunting over a period of time, and the wear could have been conducive to hunting at the time of the accident at a speed of about 60 mph. If the 45-mph speed restriction required for the 71st car had been observed by the traincrew, the critical speed, 50 mph to 60 mph, at which the 53d car would have begun to hunt or to hunt in a violent manner, would not have been reached. The lack of either compressive or tensile forces on the car may have contributed to the car's climbout, since essentially it was running free. The overspeed movement of the train from the maximum authorized speed, as determined by the computer simulation, contributed to the cause of the derailment.

The computer simulations indicated that the make-up of Extra 9164 West did not cause excessive compressive forces as the train descended the grade from Honda to Surf in the operational mode described by the engineer. However, when different operating techniques were programmed into the computer, excessive values of compressive forces could be developed in the drawbars of the cars with heavy loads. If the engineer had used the airbrakes between Oxnard and Surf, a derailment probably would have occurred. Also, the L/V ratio was high in that same heavily-loaded part of the train, which indicates the probability of a car liftout or rail climb.

Since the computer program did not include the mechanical condition of the equipment, actual track conditions, or of certain operating characteristics, the results of the simulated run do not eliminate the possibility that track/train dynamics affected the movement of the train. Also, the computer printout of L/V ratio values were instantaneous static results and the behavior of the train as a continuing output was not available. Therefore, the Safety Board concludes that the interaction of the train with the track influenced the behavior of Extra 9164 West.

The derailment of Union Pacific Railroad Company (UP) Extra 2800 East at Hastings, Nebraska, on August 2, 1976 4/ was precipitated by the UP's improperly placing a block of heavy cars at the rear of a 116-car freight train. The compressive forces that developed in the 42d, 43d, and 44th cars in the train caused them to jackknife in an area in which track work was being performed. The Safety Board believes that the SP and the railroad industry in general should review the results of studies in track/train dynamics and apply these principles more diligently in the make-up of long trains.

Hazardous Materials

The fumes from the residual hydrogen fluoride in the punctured tank car and the plaster dust cloud made it virtually impossible for persons involved to breathe. The telegrapher-clerk and crewmembers were unknowingly subjected to a danger when they encountered the gas and dust cloud. The head brakeman of the Lompoc local and the conductor of Extra 8874 East were on their trains when the tank was punctured. If breathing apparatus had been available, these men would not have suffered as much from the effects of the gas fumes and plaster dust; moreover, in some circumstances, their ability to render needed assistance on-scene would have been enhanced. The Safety Board recognizes that even if breathing apparatus had been available on the trains, most of the

4/ Railroad Accident Report--"Union Pacific Railroad Freight Train Derailment, Hastings, Nebraska, August 2, 1976" (NTSB-RAR-77-1).

men were not close enough to the cabooses or locomotives to be able to pick up the apparatus. Despite this, the Safety Board believes that railroads should consider placing breathing apparatus in the locomotive cabs and cabooses of trains carrying hazardous materials for use by crewmembers in case of a hazardous materials spill.

The Disaster Response Team from Vandenberg AFB responded within 30 minutes and conducted a well-organized effort to control and evacuate the area. The team dispatched victims to a hospital for treatment and established a checkpoint for controlling access to the area. In addition, the team, with the help of the conductor of Extra 8874 East, attempted to identify the commodities involved in the accident to determine the extent of the hazard confronting them and the toxicity of the gas and dust cloud. The team responded and performed in a highly creditable manner, and their controlled oversight of the activities may have saved lives and prevented serious injuries.

The SP computer system on which the SP relies heavily for identifying hazardous materials in SP over-the-road trains was out of service on the morning of May 22, 1981. In the absence of a working system, the method was limited by the availability of the computer system and is vulnerable. The SP should furnish its crewmembers located in the locomotive and the caboose of each train carrying cars containing hazardous materials or "empty" cars that last contained hazardous materials with data to be used to locate the hazardous materials cars in the train and, as a minimum, to identify the commodity or the tank car's last contents. The Safety Board believes that if accurate data had been available on Extra 9164 West, the hydrogen fluoride that was escaping from the tank car might have been neutralized sooner. The SP's new format for consists should provide an effective system for timely, on-scene information.

The Safety Board discussed the problem posed by "empty" tank cars in its report of a 1970 accident at Soundview, Connecticut. 5/ At Surf, the contents of an "empty" hazardous materials tank car injured 17 persons. The exact quantity of hazardous materials (hydrogen fluoride) in the car could not be determined from documents furnished to the railroad. Despite the stenciling of the product name on the car and the "empty" placards, the carrier and others had no way of assessing the danger posed by the "empty" car in the accident without knowledge of the amount of product left in the car.

Current "communication" regulations in 49 CFR 172 for "empty" tank cars provide for the top 1/3 of DOT tank car placards to be covered by a black triangle with the word "empty." Regulations require the class name to appear in the midsection of the placard. When the top 1/3 of the placard is covered with the "empty" triangle, it obscures the class pictograph on the placard. Regulations due to become effective on November 1, 1981, require the inclusion of the United Nations commodity identification numbers on placards. It is assumed that the commodity numbers will remain on "empty" placards, but the regulations allow the option of a permanent orange panel with the United Nations commodity identification number. Thus, the possibility of both the loss of the pictographic identifier and the class identifier exists. Because the Uniform Freight Classification Tariff Rule 35, Section 7 permits an "empty" tank car to contain as much as 1/3 of the quantity shown on billing documents for the last revenue-paying shipment, tank cars containing up to 1/3 carload of hazardous materials may be moving in transportation without adequate identification of the contents on the car or on the accompanying railroad documentation.

5/ Railroad Accident Report--"Penn Central Transportation Company Freight Train Derailment and Passenger Train Collision with Hazardous Material Car, Soundview, Connecticut, October 8, 1970" (NTSB-RAR-72-1).

In view of these circumstances, the Safety Board believes that the petition of the IAFC to amend the safety regulations to provide more adequate safety information is timely and has merit.

CONCLUSIONS

Findings

1. Extra 9164 West was being operated overspeed for a restricted-speed car and at authorized speed for a freight train passing through Surf, as indicated by the computer simulation.

2. Extra 9164 West was being given a rollby inspection by qualified employees as required by the SP operating rules.

3. The initial derailment involving wheel climb by the 53d car occurred immediately east of the railroad office at a grade crossing and the major derailment began at the crossover 1,100 feet west of the office when the derailed wheels of the 53d car struck the track frog in the crossover.

4. The No. 4 brake beam from the "A" end truck of the 53d car was not a causal factor in the derailment because it dropped out after the car derailed.

5. If the speed restriction for the restricted speed car had been observed, the speed at which empty boxcars are known to hunt would not have been reached.

6. Although the train make-up placed heavily loaded cars toward the rear of the train behind lightweight empty cars, there is no evidence to indicate this was a contributing factor in the derailment.

7. The Disaster Response Team from Vandenberg AFB probably prevented further injuries by its prompt, well-organized response.

8. The carrier and personnel responding to the emergency did not have needed information from the shipper for timely determination of the dangers posed by the hazardous material carried in the breached "empty" tank car.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the derailment of the trailing truck of the 53d car from the locomotive, an empty boxcar, at the entrance spiral to a 1° right curve because of hunting and wheel climb due to track/train dynamics. The derailed car continued on the track structure for about 1,100 feet until it struck a track frog in a crossover. The trailing truck then became detached from the car body and the following 38 cars derailed, striking cars standing on adjacent tracks. Contributing to the accident was the overspeed movement of the train.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board recommends that the Materials Transportation Bureau:

> Amend 49 CFR 171.8 to define in specific quantities the maximum quantity of a hazardous material that may be moved in a tank car placarded under 49 CFR 172.525 and offered for transportation by a shipper as an "empty" tank car under DOT regulations. (Class II, Priority Action) (R-81-97)
>
> Amend 49 CFR 174.25(c) to require that shippers show on shipping papers the approximate weight of a hazardous material contained in a tank car offered by the shipper to a carrier as an "empty" tank car for movement under Rule 35 of the Uniform Freight Classification Tariff. (Class II, Priority Action) (R-81-98)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS and PATRICIA A. GOLDMAN, Members, did not participate.

September 15, 1981

APPENDIXES

APPENDIX A

INVESTIGATION

The Safety Board was notified of this accident on the morning of May 22, 1981. The Safety Board dispatched a field investigator from its Los Angeles field office who arrived at Surf about 10 p.m. His late arrival was the result of his being at another accident scene conducting an investigation. An Investigator-in-Charge was dispatched to Surf from the Washington, D.C., headquarters about 5 p.m. on May 22. He arrived on the scene about 2 p.m., May 23. A second Washington Headquarters investigator joined the investigative team at Sacramento, California, on May 29, 1981.

APPENDIX B

CREWMEMBER INFORMATION

Extra 9164 West called for duty at 5:30 p.m., on May 21, 1981, at Los Angeles, California.

Robert D. Swain, Engineer

Robert D. Swain, 34, was employed by the Southern Pacific Transportation Company on June 1, 1970, as a student fireman. He was promoted to engineer on December 12, 1972. He was up-to-date on operating rules examinations. Mr. Swain had been off duty 14 hours when he called for duty on May 21.

Charles E. Johnson, Fireman

Charles E. Johnson, 31, was employed by the Southern Pacific Transportation Company on June 14, 1972, as a student brakeman. He transferred into engine service on May 15, 1973, as a fireman, and he was promoted to engineer on September 22, 1974. He was up-to-date on operating rules examinations. He had been off duty 14 hours when he was called for duty on May 21.

APPENDIX C

EXCERPTS FROM SOUTHERN PACIFIC TRANSPORTATION COMPANY OPERATING RULES

No. 829 - When a train stops to be met or passed by another train, trainman on headend of train must make a rolling inspection of passing train from the ground on the side opposite his train. Trainman at the rear of standing train must make rolling inspection from the ground on the side adjacent to their train. . . .

No. 916 - When trains are passing, operator must be on platform prepared to make a rolling inspection, except when excused by train dispatcher or when a train order is held for delivery to that train restricting it at the station.

*U.S. GOVERNMENT PRINTING OFFICE : 1981 0-361-828/77

Engineering

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

DERAILMENT OF AMTRAK TRAIN NO. 97 ON SEABOARD COAST LINE RAILROAD TRACK LOCHLOOSA, FLORIDA MAY 26, 1981

NTSB-RAR-81-9

UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-RAR-81-9	2. Government Accession No. PB82-124009	3. Recipient's Catalog No.
4. Title and Subtitle Railroad Accident Report—Derailment of Amtrak Train No. 97 on Seaboard Coast Line Railroad Track, Lochloosa, Florida, May 26, 1981		5. Report Date September 29, 1981 6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address National Transportation Safety Board Bureau of Accident Investigation Washington, D.C. 20594		10. Work Unit No. 3366 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Railroad Accident Report May 26, 1981 14. Sponsoring Agency Code

15. Supplementary Notes

The subject report was distributed to NTSB mailing lists: 8A, 8D, 14A and 14B.

16. Abstract

At 12:30 p.m. on May 26, 1981, southbound Amtrak train No. 97, operating over Seaboard Coast Line Railroad track, derailed in Lochloosa, Florida. The locomotive and nine-car train derailed at a previously damaged switch leading to a siding that paralleled the main track. Nine passengers and nine Amtrak employees were injured; damage was estimated at $241,258.

The National Transportation Safety Board determines that the probable cause of this accident was the movement of train No. 97 through a damaged and improperly positioned track switch that was not properly signalled because of an inverted relay that interfered with the normal functioning of the signal circuitry. Contributing to the accident were the Seaboard Coast Line's (SCL) conflicting Signal and Operating Department instructions and policies influencing the signal maintainer, the SCL's lack of specific written instructions to prevent the practice of inverting a signal relay to avoid train delay during signal maintenance, and the SCL's lack of adequate quality control or supervision to ensure compliance with existing Federal safety regulations applicable to the railroad signal system.

17. Key Words derailment; passenger train; signal system; traffic control system; false-clear signal aspect; run-through switch; improperly aligned switch; inverted relay		18. Distribution Statement This document is available to the public through the National Technical Information Service-Springfield, Virginia 22161 *(Always refer to number listed in item 2)*	
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CONTENTS

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

RAILROAD ACCIDENT REPORT

Adopted: September 29, 1981

DERAILMENT OF AMTRAK TRAIN NO. 97 ON SEABOARD COAST LINE RAILROAD TRACK LOCHLOOSA, FLORIDA MAY 26, 1981

SYNOPSIS

At 12:30 p.m. on May 26, 1981, southbound Amtrak train No. 97, operating over Seaboard Coast Line Railroad track, derailed in Lochloosa, Florida. The locomotive and nine-car train derailed at a previously damaged switch leading to a siding that paralleled the main track. Nine passengers and nine Amtrak employees were injured; damage was estimated at $241,258.

The National Transportation Safety Board determines that the probable cause of this accident was the movement of train No. 97 through a damaged and improperly positioned track switch that was not properly signalled because of an inverted relay that interfered with the normal functioning of the signal circuitry. Contributing to the accident were the Seaboard Coast Line's (SCL) conflicting Signal and Operating Department instructions and policies influencing the signal maintainer, the SCL's lack of specific written instructions to prevent the practice of inverting a signal relay to avoid train delay during signal maintenance, and the SCL's lack of adequate quality control or supervision to ensure compliance with existing Federal safety regulations applicable to the railroad signal system.

INVESTIGATION

The Accident

At 10:50 a.m., e.d.t., 1/ on May 26, 1981, southbound Amtrak train No. 97, consisting of one locomotive unit and nine cars, departed Jacksonville, Florida, on the tracks of the Seaboard Coast Line Railroad (SCL) en route to Miami, Florida. A crew change and satisfactory air brake test were made in Jacksonville.

As train No. 97 approached Lochloosa, Florida, it was being operated on authority of a "proceed" signal indication and was in compliance with a 75-mph speed restriction for a curve in the area. As the train moved out of the curve, the enginecrew observed a "clear" aspect being displayed by home signal No. 7113 at the north switch for the siding at Lochloosa about one-half mile ahead. They acknowledged the signal as required by the rules, and the engineer advanced the locomotive's throttle to maximum power.

1/ All times herein are Eastern daylight time.

As the train accelerated, the home signal for the north switch of the Lochloosa siding continued to display a "clear" aspect. When the train was about 250 feet from the right-hand facing point switch, the engineer observed that the west switch point was not properly closed against the rail as needed for the main track route indicated by the signal aspect. He immediately instructed the fireman to brace himself and initiated an emergency application of the train's air brakes with the automatic brake valve. The train was moving at a recorded 76 mph. (See appendix C.) When the locomotive passed through the improperly aligned switch, it derailed to the right between two tracks and remained upright. The cars in the train followed the locomotive and derailed, but they also remained upright, coupled, and approximately in line with the track structure. There was no fire. (See figure 1.)

The flagman detrained and used the wayside telephone to notify the train dispatcher of the derailment. He requested emergency equipment to handle possible injuries. The train dispatcher called the operator at Hawthorne, Florida; the operator notified the Alachua County Emergency Response Center. About 30 minutes later, several ambulances and rescue squad personnel arrived at the derailment site.

Upon learning of the circumstances of the derailment, the SCL Signal and Communications Supervisor of the Jacksonville Division immediately issued instructions to seal all signal cases and the relay house associated with the signal system at the north end of the Lochloosa siding. About 1 p.m., the seals were applied by an Assistant Signal Supervisor. About 2:30 p.m. on the same day, the Division Signal Supervisor, accompanied by the Division Superintendent, the Assistant Signal Supervisor, the signal maintainer for the territory, and a representative of SCL's Police and Special Services Department, broke the seals that were applied earlier and unlocked the relay house. When they entered the house, the normal switch repeater relay (NWPR) was found in an inverted position. With the NWPR relay in this position, the signal system reacts as to a normal switch position, i.e., lined for main track movement, regardless of actual switch position. There was no evidence to suggest that the relay house had been entered previously by unauthorized persons using tools to force entry. Other than the NWPR relay, all other signal equipment in the relay house was properly in place and operating normally.

Events Preceding the Accident

On May 15, 1981, the signal maintainer whose territory included the Lochloosa siding was advised by a train dispatcher that the switch-position indicating light for the north-end switch of the Lochloosa siding was illuminated properly on the traffic control console in the dispatcher's office but was reacting abnormally upon the passage of a train. The maintainer determined upon inspection that a worn circuit controller mechanism at the switch was malfunctioning. He immediately arranged to obtain a replacement circuit controller, which was received during the following week.

On May 20, shortly after 1 p.m., the signal maintainer arrived at the north switch of the Lochloosa siding to replace the circuit controller. He contacted the train dispatcher by telephone, advised the dispatcher of his presence at the siding and his intention to work on the switch circuit controller, and asked when trains were expected to pass his location. The train dispatcher informed him that a southbound freight train was due by Lochloosa at 1:30 p.m., and that northbound Amtrak train No. 98 was running late and would be at Lochloosa shortly after 3 p.m.

After the southbound freight train passed Lochloosa, the signal maintainer began to replace the circuit controller. He stated that during the preparation he inverted the NWPR relay. About 3 p.m., he informed the dispatcher that he had finished exchanging and adjusting the circuit controller. The maintainer asked the dispatcher to check on the

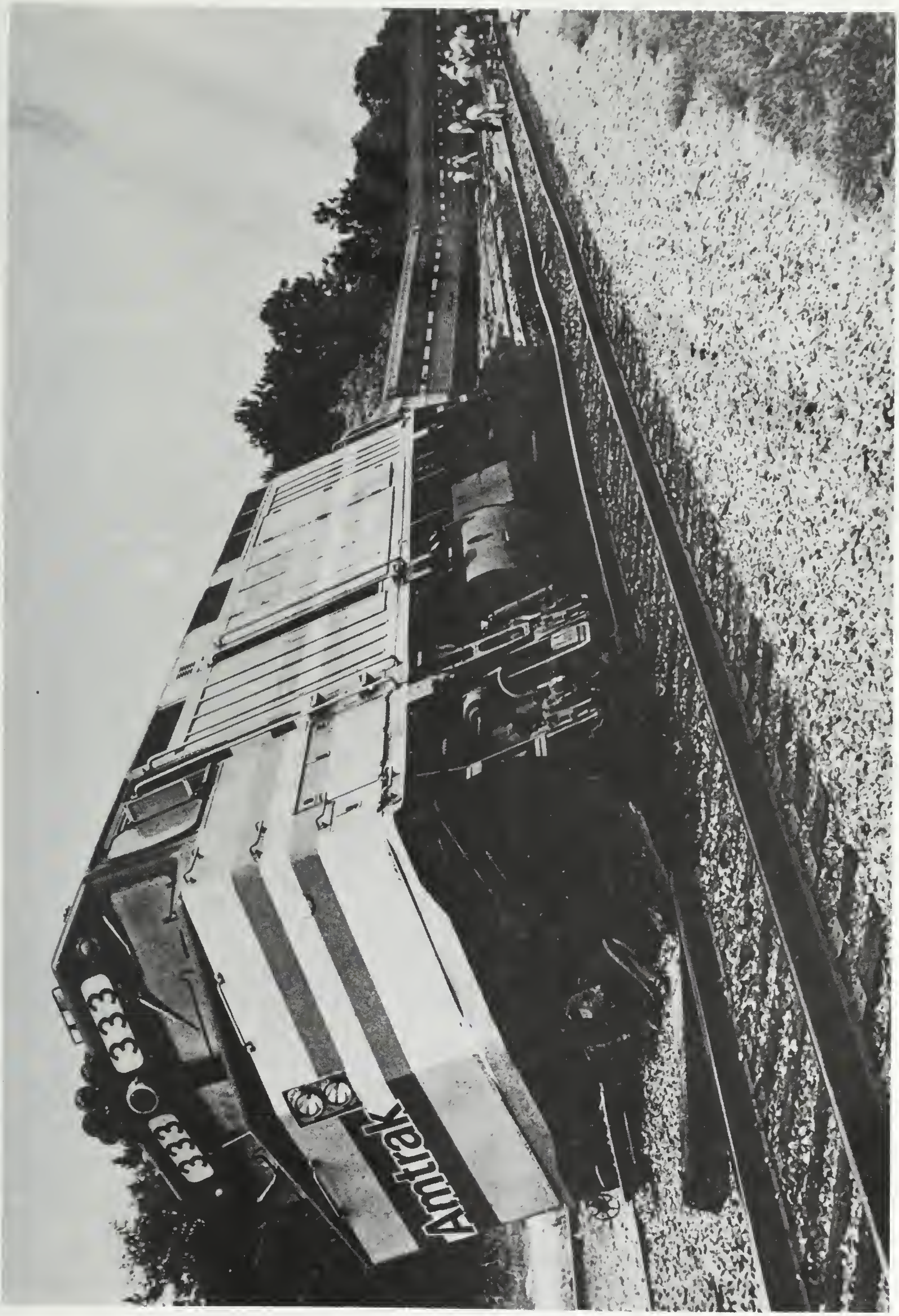


Figure 1.—Derailed locomotive and cars of train No. 97.

location of train No. 98 because he wanted the dispatcher to test the remote operation of the switch and new circuit controller. The maintainer stated that the dispatcher discussed with him the possible delay to train No. 98 if the test was made. The maintainer asked the dispatcher to operate the switch anyway. The maintainer said he told the dispatcher, "if you don't have a signal lined up, I'll catch time for it." 2/ The maintainer stated that after observing the activation of the switch to both the normal and reverse positions by the dispatcher, 3/ he returned to the relay house and placed the NWPR relay in its proper operating position and waited for the arrival of train No. 98. He said that, as train No. 98 passed, he "sat on the step outside and watched the NWPR relay the whole time [the train] went over the switch; it [the relay contacts] never went down." 4/ After completing his work on May 20, the signal maintainer did not return to the north end of the Lochloosa siding until about one-half hour after the derailment on May 26.

An examination of the train graph produced by the traffic control equipment in the train dispatcher's office in Jacksonville indicated that the Lochloosa siding had not been used for train traffic between May 19 and early on May 26, 1981. About 4:10 a.m. on May 26, in a planned passing maneuver, northbound freight train No. 174 entered the siding via the south switch and exited via the north switch after southbound freight train No. 173 had passed on the main track. When questioned afterward, the train dispatcher could not recall the exact procedure he used to "normal" the north switch and clear the signal following this move. 5/ Reportedly, the wayside and the dispatcher's console signal indications and indicator lights were observed to be correct for the passing maneuver. At 6:10 a.m., a second northbound train, No. 178, passed Lochloosa siding while operating on the main track. The locomotive crewmembers of train No. 178 indicated that they received "clear" signal aspects throughout the Lochloosa area and did not observe the switch point position at the north end of the siding. The next train movement indications on the train graph were made by train No. 97. The graph showed that southbound train No. 97 arrived at the north end of the Lochloosa siding about 12:30 p.m.--the time of the derailment.

Injuries to Persons

			Amtrak Employees		
Injuries	Passengers	SCL Traincrew	On-Duty	Off-Duty	Total
Fatal	0	0	0	0	0
Nonfatal	9	0	6	3	18
None	118	5	9	0	132
Total	127	5	15	3	150

2/ Refers to disciplinary action against the maintainer for delaying a train.
3/ Normal switch position is lined for straight movement. Reverse switch position is lined for another track.
4/ At a later demonstration of how he observed the relay, the signal maintainer found it necessary to stand with his head in the doorway of the relay house to make the observation.
5/ The traffic control console can be set by the dispatcher to send single codes for switch and signal operation or a composite code to cause first the switch to operate and then the signal to operate.

Damage

The entire consist of train No. 97 derailed except for the wheels on the trailing truck of the last car, but the train remained upright. (See figure 2.) The locomotive sustained damage to the trucks, fuel tank, and snowplow pilot. The locomotive's trailing truck became disengaged from the car body during the derailment. Damage incurred by the cars was limited to trucks and equipment under the car bodies, except for the fourth and fifth cars which sustained cornerpost damage when they began to jackknife before stopping.

There was extensive damage to the trackage of the siding and the stub-end track that paralleled the siding on the west.

Inspection of the switch at the north end of the Lochloosa siding disclosed that the operating rod was bent in a northerly direction and that the operating bar of the power switch machine was fractured and lying on the ballast near its original point of attachment. (See figure 3.) The east switch point indicated evidence of wheel contact due to being run through, and wheel abrasions were observed on the north end of the heel block of the east switch point. Damage was estimated as follows:

Locomotive	$ 40,000
Equipment	152,000
Track	33,335
Signal	5,000
Clearing	10,923
Total	$241,258

Employee Information

The crewmembers of train No. 97 reported for duty at 10:20 a.m. at Jacksonville. The engineer and fireman were to operate to Wildwood, Florida; the traincrew was assigned to work through to Miami, Florida. Each crewmember was qualified for his position under SCL standards. (See appendix B.)

The signal maintainer was employed by the SCL in October 1969 as a signal helper and assistant signalman. He had worked almost continuously in the territory that included the Lochloosa siding since his promotion to signalman on November 30, 1970. He learned his duties as a signal maintainer through on-the-job training; no classroom training was provided at the time. He said that, during his on-the-job training, he had seen senior signal maintainers and their immediate supervisors invert relays.

The signal maintainer's headquarters was located in Waldo, Florida, at milepost (MP) 690. He was assigned a territory which extended from the south end of Hampton, MP 685.6, to the north end of Sparr, MP 718.5. This territory involved 36 miles of a traffic control signalized system and associated signal apparatus. The apparatus included an automatic interlocking at a railroad crossing, hot box and dragging equipment detectors, and highway warning systems. On May 20, 1981, the maintainer was in compliance with 49 CFR 228.19 regarding hours-of-service.

The signal maintainer had attended an operating rules examination class on April 22, 1980, and acknowledged receipt of SCL's Signal Instruction Letters No. 5 and 6 prior to May 20, 1981. Signal Instruction Letter No. 5 (see appendix D) listed several Federal

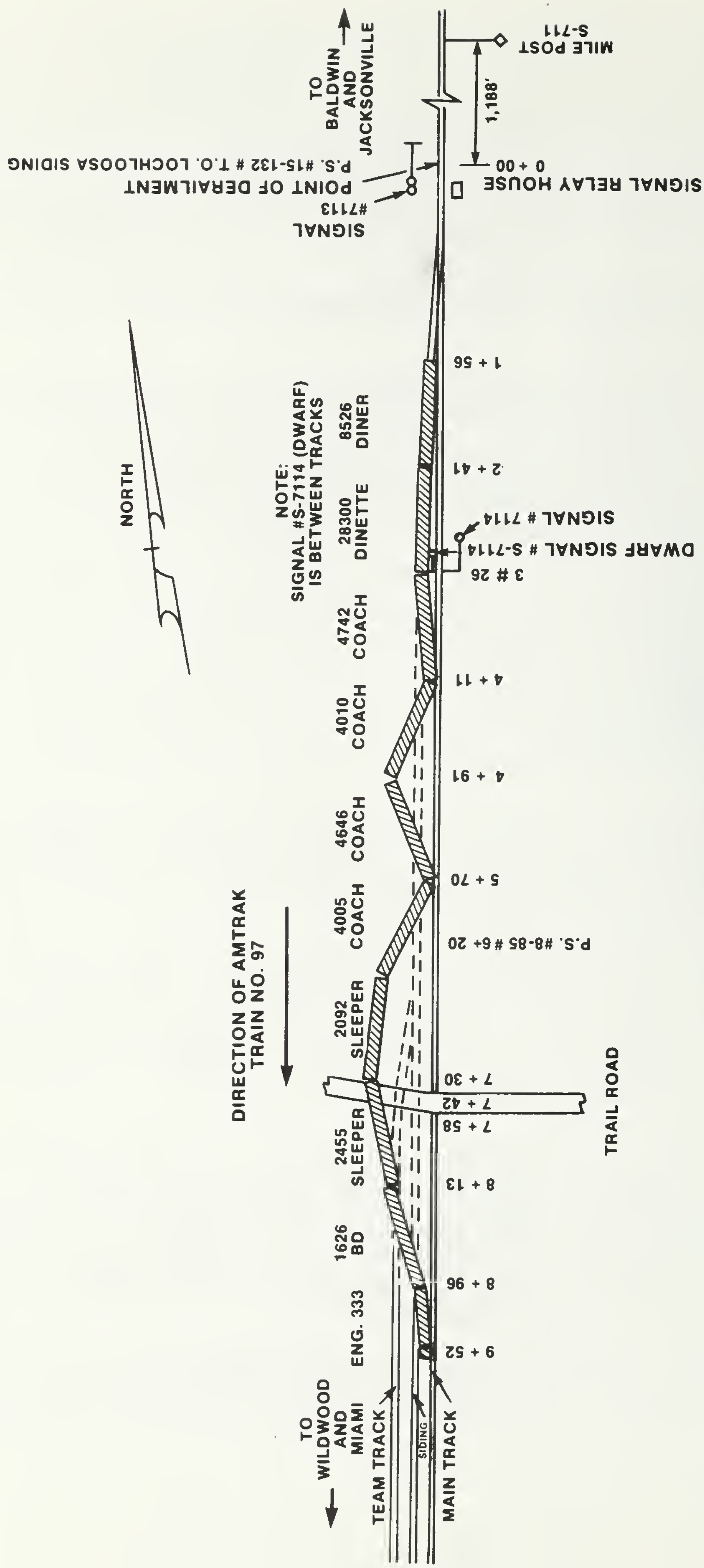


Figure 2.--Plan view of accident site.

Figure 3.—Switch machine and bent operating rod.

Railroad Administration (FRA) Rules, Standards and Instructions for Railroad Signal Systems including the following:

> [49 CFR] 236.4 Interference with normal functioning of device.
>
> The normal functioning of any device shall not be interfered with in testing or otherwise without first taking measures for insuring safety of train operation which depends on normal functioning of such device.

Signal Instruction Letter No. 6 (see appendix E) stated:

> Operating Rule 1181 states, [Signal maintainers] shall be responsible for the proper maintenance and operation of all equipment in their charge and shall do no work thereon that will delay or interfere with the safe passage of trains. Their work must be programmed so that it does not cause delay to trains. They shall conform to prescribed standards and plans in the execution of work in their charge. They shall not make or permit any changes without authority.

Train Information

The train consisted of, from front to rear, a General Motors Corporation Electro-Motive Division (EMD) Model F-40 PH diesel-electric locomotive unit, a baggage car, two sleeping cars, four coaches, a dinette car, and a dining car. The locomotive was equipped with a 26L air brake system, a speed indicator, and a speed recorder.

Track Information

The single main track in the vicinity of the accident site consisted of 132-pound R E continuous welded rail (CWR) on 8-inch by 14-inch, double-shouldered tie plates

supported by mixed hardwood crossties and granite ballast. A siding paralleled the main track on the west for 10,908 feet between the north and south end switches at Lochloosa. A stub end team track was parallel to the siding on the west and extended southward 500 feet from the point-of-switch, which was 620 feet south of the switch at the north end of the Lochloosa siding. All the tracks were tangent and level throughout the derailment area. The main track was maintained to FRA Class 4 standards or better.

The No. 15 right-hand turnout at the north end of Lochloosa leading from the main track to the siding used two 26-foot-long switch points and a railbound manganese frog. The switch was operated by a direct-current, electric switch machine. A connecting rod between the switch points and circuit controller was arranged so switch point position was determined by an electrical circuit which was part of the signal system.

Method of Operation

Train movements were governed by signal indications of a traffic control system operated by a train dispatcher in Jacksonville. The train dispatcher, through use of a control console, could control the switches and interlocking home signals. Maximum train speed for passenger trains was 79 mph. The single main track in the vicinity of the derailment was provided with a siding used for passing or meeting trains. Trains departed the siding upon receipt of a proceed signal.

The traffic control and automatic block signal system used continuously lighted signals of the color-light type. The southbound home signal for the switch at the north end of the Lochloosa siding was mounted on a mast west of the track. The mast was equipped with two signal heads, each having three lights vertically arranged to display signal aspects in accordance with the SCL Operating Rules.

The traffic control system used an electronic sending and receiving code unit and a pole line to transmit the code from Jacksonville to the field locations. By use of this system, power switch positions and controlled signal indications controlling train movements, with the exception of conditions of track occupancy, are operated by the train dispatcher. Each power switch and home signal had a relay house for the protection and maintenance of the electrical relays associated with the system. According to some signal maintainers, other SCL personnel may have keys that allow them unauthorized access to signal relay houses and to signal equipment.

The NWPR relay used at Lochloosa relies on gravity to hold the relay in its deenergized position. If the relay is inverted manually, the contacts will complete circuits that normally would be open when the relay's operating coil is not energized with electrical current. A circuit controller that is designed and adjusted to indicate the position of the track switch by supplying a circuit to appropriate relays for indicating and controlling the switch and signal can be made ineffective by inverting the NWPR relay. Because of the circuit design, inverting the NWPR relay would have caused the signal to indicate "proceed" regardless of the switch position. The same relay was used to provide a normal switch position indication on the dispatcher's traffic control console.

In more recently designed signal circuits, an inverted relay would not have allowed the home signal to display a clear aspect because circuit cross-checks would have been performed differently and a circuit anomaly would have been detected. As a result of the inverted relay found at the north end of the Lochloosa siding, the SCL's signal department management immediately took steps to prevent a recurrence of this action. On June 1, 1981, a written instruction prohibiting the inverting of relays was sent to appropriate signal department personnel. (See appendix F.)

After formation of the National Railroad Passenger Corporation (Amtrak) and the beginning of its operation on contract railroads, Amtrak found that its trains were being delayed at times to allow passage of freight trains. To eliminate this problem, Amtrak management installed an on-time monetary incentive program with its contractor railroads, which has succeeded in expediting Amtrak train movements.

The contract concerning on-time operation incentive between Amtrak and the SCL for train No. 97 at the time of the derailment was about $5,000 per day for each trip of on-time performance after an 80-percent threshold per month had been reached, i.e., SCL would realize about $32,000 for 30 days of on-time operation during a month for this one train. The SCL train dispatcher, chief train dispatcher, and chief of the Signal and Communications Department each alluded to the SCL's effort to run Amtrak trains on time.

Meteorological Information

At the time of the accident, the temperature was 82° F with a cloudy sky. It was daylight and there was no atmospheric condition to restrict visibility.

Medical and Pathological Information

Most of the injuries during the derailment resulted from persons falling or being ejected from their seats. One passenger and a food service attendant were admitted to a local hospital for observation. Another food service attendant suffered a fractured finger. The other injuries were sprains, contusions, and abrasions.

Survival Aspects

At 12:32 p.m. following the accident, a telephone notification was received by the Emergency Medical Service (EMS) for Alachua County, which is headquartered in Gainesville, Florida. The EMS is responsible for monitoring incoming telephone calls on the dial emergency number 911. Within 1 minute of notification, a firetruck and an ambulance manned by a paramedic team were dispatched from Gainesville, about 25 miles from the accident site; they arrived onscene at 12:41 p.m. At 12:35 p.m. an ambulance and firetruck were dispatched from a station at Hawthorne, Florida, approximately 8 miles from the accident site; they arrived onscene at 1:03 p.m. The EMS Director and Assistant Civil Defense Director for Alachua County arrived shortly afterward and set up a command post at the Civil Defense vehicle. The injured were triaged by paramedics and those requiring hospital examination and/or treatment were transported to local hospitals in the Gainesville area.

The EMS Director indicated that he believed that the time consumed in getting the injured to the triage point may have been too long and could have been better organized by Amtrak or railroad employees. However, the triage point was not readily identified in a manner recognized by railroad employees.

Other Information

The Safety Board's investigation revealed that on March 18, 1981, two SCL signal maintainers working on a switch machine at MP 847 did not follow SCL Signal Instruction Letter No. 6, by not putting signals at stop, and Amtrak train No. 87 made a high-speed trailing move through a switch on a false "clear" signal aspect. (See appendix G.) The FRA has informed the Safety Board that it is examining the circumstances concerning this incident and the accident on May 26, 1981.

ANALYSIS

The absence of train movement through the Lochloosa siding between May 19 and May 26, the day of the accident, allowed the condition created by the inverted relay to remain undetected since the switch was always in its normal main track position. The passing of the two opposing trains at Lochloosa siding on May 26 did not reveal the improper condition because the train in the siding left through the north switch and the switch machine was able to move the switch points to the reverse position. Reportedly, the wayside and the dispatcher's console signal indications and indicator lights were observed to be correct for the passing maneuver. Therefore, there was no reason for the traincrews or the train dispatcher to suspect that a problem existed in the signal system and that the switch had not functioned properly by not returning to its normal main track position after the train left the siding. If the train dispatcher, during the passing of the opposing trains, coded a single command to move the switch to its normal position after the train left the siding, and waited for a normal switch indication to be received on his console, and then coded a signal command, the switch would have gone to the normal position. However, if he positioned the switch lever and the signal lever at the same time to obtain the desired routing, and sent a composite command code to the signal equipment at the north end of the Lochloosa siding, power would have been applied only momentarily to the switch machine motor due to the inverted NWPR relay. This action would have left the switch either lined for the siding or only partially moved toward a full normal position. Because of the inverted relay, a clear signal aspect for both northbound and southbound trains was possible.

The second northbound train, No. 178, to pass the north switch in a trailing position at Lochloosa on May 26 received a clear signal aspect even though the switch was not lined for the main track over which it was operating. The damage to the switch components indicates that the switch had been run through while it was set against the train movement. The wheel marks on the back of the east switch point and the absence of similar marks on the west point indicate that train No. 178 ran through the switch.

Engineers usually look at the position of switch points before passing over a switch. If the crewmembers on the locomotive of train No. 178 had noted the reversed position of the switch and reported it to the dispatcher, the derailment of train No. 97 might have been prevented. However, the primary causal factor was the inversion of the NWPR relay. With the NWPR relay inverted, it was possible for the switch points, even if not damaged, to have been left gapped open and a clear signal displayed.

SCL Signal Instruction Letter No. 6 explicitly detailed the procedures to be used by the signal maintainer for an equipment change such as the circuit controller exchange at Lochloosa. The written instruction clearly indicated that when signal circuits or apparatus were being changed, signals were to be set to "stop" train movements until the work was completed. On the other hand, the wording of SCL Operating Department Rule 1181 quoted in Signal Instruction Letter No. 6 and the discussion between the train dispatcher and the maintainer indicated that trains were not to be delayed. Since the inverting of a relay was frequently observed by the maintainer during his on-the-job training, and accepted as a practice by supervisors of the Signal Department, the "no train delay" admonition of the Operating Department apparently prevailed within the Signal Department as well. As a result, the signal maintainer was faced with a dilemma--either follow the unwritten but accepted practice of inverting the relay to avoid train delay, or follow the written instructions of a departmental officer to place signals at stop. The circumstances suggest that the threat of possible disciplinary action if trains were delayed as a result of his maintenance work may have been the major factor in his decision to invert the relay. He knew that if he followed the written instruction to set the signal to "stop," train No. 98 would be delayed. The signal maintainer stated that

fearing a delay to a passenger train could lead to a suspension and/or a reprimand, he chose to invert the relay. This action may have been contrary to 49 CFR 236.4 since the investigation did not disclose any actions taken by the maintainer to first ensure the safety of train operations which depended on the normal functioning of the relay.

There was no evidence found to indicate that the accident resulted from an act of vandalism. Additionally, if a person other than the signal maintainer had entered the signal relay house to sabotage the equipment, more than one vital relay probably would have been inverted or disturbed. The signal maintainer stated that he returned the inverted NWPR relay to its normal position after completing the circuit controller exchange on May 20, 1981. Then, as train No. 97 passed over the north switch of the Lochloosa siding, he watched the relay operate while he sat on the step outside the relay house. At a later demonstration as to how he observed the pertinent relay, he found it necessary to stand with his head in the doorway of the relay house to make the observation. The signal maintainer's statement regarding the relay observation and the lack of evidence of vandalism or sabotage leads the Safety Board to conclude that the signal maintainer was the only person to have handled the NWPR relay between May 20 and May 26 and that he forgot to return the NWPR relay to its proper operating position on May 20, 1981.

The previous Amtrak incident on March 18, 1981, and the circumstances disclosed in this accident investigation indicate that the practice of allowing trains to continue operation while work is being performed on the signal system, regardless of written instructions to set signals at "stop," apparently occurs because of the SCL's lack of specific written instructions to prevent the practice of inverting the relay. Because of the significant monetary incentive for on-time Amtrak train operation, the practice may be particularly pronounced when Amtrak trains are involved.

The FRA has the responsibility to enforce Federal regulations governing railway signal systems for interstate rail carriers. However, because of the number of miles of signalized track and the limited number of Federal signal inspectors, effective Federal surveillance of the systems on a continuing basis has not been practicable. Consequently, the quality control of maintenance methods and standards has been left largely to the judgment of individual signal maintainers with occasional oversight by their supervisors. Most signal maintainers spend their workdays alone and unobserved; many of their work decisions are discretionary.

At the SCL, those discretionary judgments on occasion are undoubtedly compromised by the pressures brought about by the rule and practice not to delay trains, particularly Amtrak trains. Safety and the effective use of safety measures may be diminished as a result of this practice. This practice suggests that the SCL Operating and Signal Departments have conflicting or incompatible rules and instructions pertaining to train delays. The ability to invert the NWPR relays and the tacit condoning of this practice demonstrated that the SCL did not have either effective procedures to ensure that signal maintainers comply with signal instructions or a signal system in the Lochloosa area that functioned in a manner to detect an improper switch position and noncorresponding signal indication as possible in newer circuit designs. The SCL's written instructions of June 1, 1981, prohibiting the inverting of relays hopefully will eliminate this practice.

CONCLUSIONS

Findings

1. During maintenance on the north switch of the Lochloosa siding on May 20, 1981, the signal maintainer inverted the NWPR relay to avoid delaying Amtrak

train No. 97 and forgot to replace the relay in the correct position when he had finished his maintenance work.

2. The train dispatcher apparently used a composite code to align the switch and condition the signal at the north end of the Lochloosa siding after train No. 174 left the siding on May 26, 1981. This and the inverted relay prevented the switch from returning to its normal position.

3. On May 26, 1981, northbound train No. 178 damaged the switch when the train trailed through the north switch of the Lochloosa siding while it was aligned for the siding and while the train was operating on a false "clear" signal aspect.

4. On May 26, 1981, southbound Amtrak train No. 97 derailed at the damaged north switch of the Lochloosa siding while operating on a false "clear" signal aspect.

5. The signal system at Lochloosa did not have crosscheck circuitry to detect the position of the NWPR relay, which would have disclosed the signal and switch position anomaly.

6. The inverting of the NWPR relay without first taking other measures to ensure the safety of train operations was contrary to Federal safety regulations (49 CFR 236.4).

7. The inverting of relays apparently occurs because of the absence of specific written instructions to prevent the practice and to ensure Federal safety signal regulation and carrier rule compliance.

8. The signal maintainer's perception of proper job performance in this case was dominated by avoiding train delay rather than by complying with signal instruction letters Nos. 5 and 6.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the movement of train No. 97 through a damaged and improperly positioned track switch that was not properly signalled because of an inverted relay that interfered with the normal functioning of the signal circuitry. Contributing to the accident were the Seaboard Coast Line's (SCL) conflicting Signal and Operating Department instructions and policies influencing the signal maintainer, the SCL's lack of specific written instructions to prevent the practice of inverting a signal relay to avoid train delay during signal maintenance, and the SCL's lack of adequate quality control or supervision to ensure compliance with existing Federal safety regulations applicable to the railroad signal system.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

—to the Seaboard Coast Line Railroad Company:

Establish procedures for signal maintainers that promote compliance with Federal railway signal regulations. (Class II, Priority Action) (R-81-99)

Establish a test procedure which confirms that a signal system is completely operative after equipment or circuitry has been changed. (Class II, Priority Action) (R-81-100)

Review and resolve operating department policies and written instructions to signal maintainers that may be in conflict and result in unsafe acts to avoid train delays. (Class II, Priority Action) (R-81-101)

--to the Association of American Railroads:

Inform its membership of the circumstances of this accident, and recommend that member railroads check their signal systems and pertinent maintenance procedures and take necessary action to prevent similar occurrences. (Class II, Priority Action) (R-81-102)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS and PATRICIA A. GOLDMAN, Members, did not participate.

September 29, 1981

APPENDIXES

APPENDIX A

INVESTIGATION

The National Transportation Safety Board was notified of the accident about 1:05 p.m., e.d.t., on May 26, 1981. The Safety Board immediately dispatched an investigator from its Atlanta Field Office to the scene at Lochloosa, Florida. Subsequently, the investigator was joined by a signal system specialist from the Railroad Accident Division in Washington, D.C. The Brotherhood of Locomotive Engineers, Brotherhood of Railroad Signalmen, Seaboard Coast Line Railroad, and Federal Railroad Administration cooperated in the investigation.

APPENDIX B

PERSONNEL INFORMATION

Conductor

Ernest C. Carter, 58, was employed as a brakeman by the Atlantic Coast Line Railroad on November 10, 1946. He passed a company physical examination on April 22, 1981, and he was last examined on the SCL operating rules on May 20, 1981. He had been a promoted conductor since May 25, 1958.

Baggage Master

Joseph Lee Boone, 38, was employed by the Atlantic Coast Line Railroad as a brakeman on December 20, 1963. His last company physical examination was April 19, 1965, upon returning to work from an illness. He was last examined on SCL operating rules on May 20, 1981.

Flagman

Melvin Lee Smith, 57, was employed by the Atlantic Coast Line Railroad as a trainman on February 24, 1948, and passed an SCL physical examination on September 30, 1980. He was last examined on SCL operating rules on May 25, 1980.

Engineer

George P. Wadsworth, 58, was employed as a yard fireman on July 1, 1942, by the Atlantic Coast Line Railroad. He was promoted to engineer on September 14, 1950. His last company physical examination was on November 18, 1980, and his last SCL operating rules examination was on March 6, 1981. He was required to wear corrective lenses, which he was wearing at the time of the derailment.

Fireman

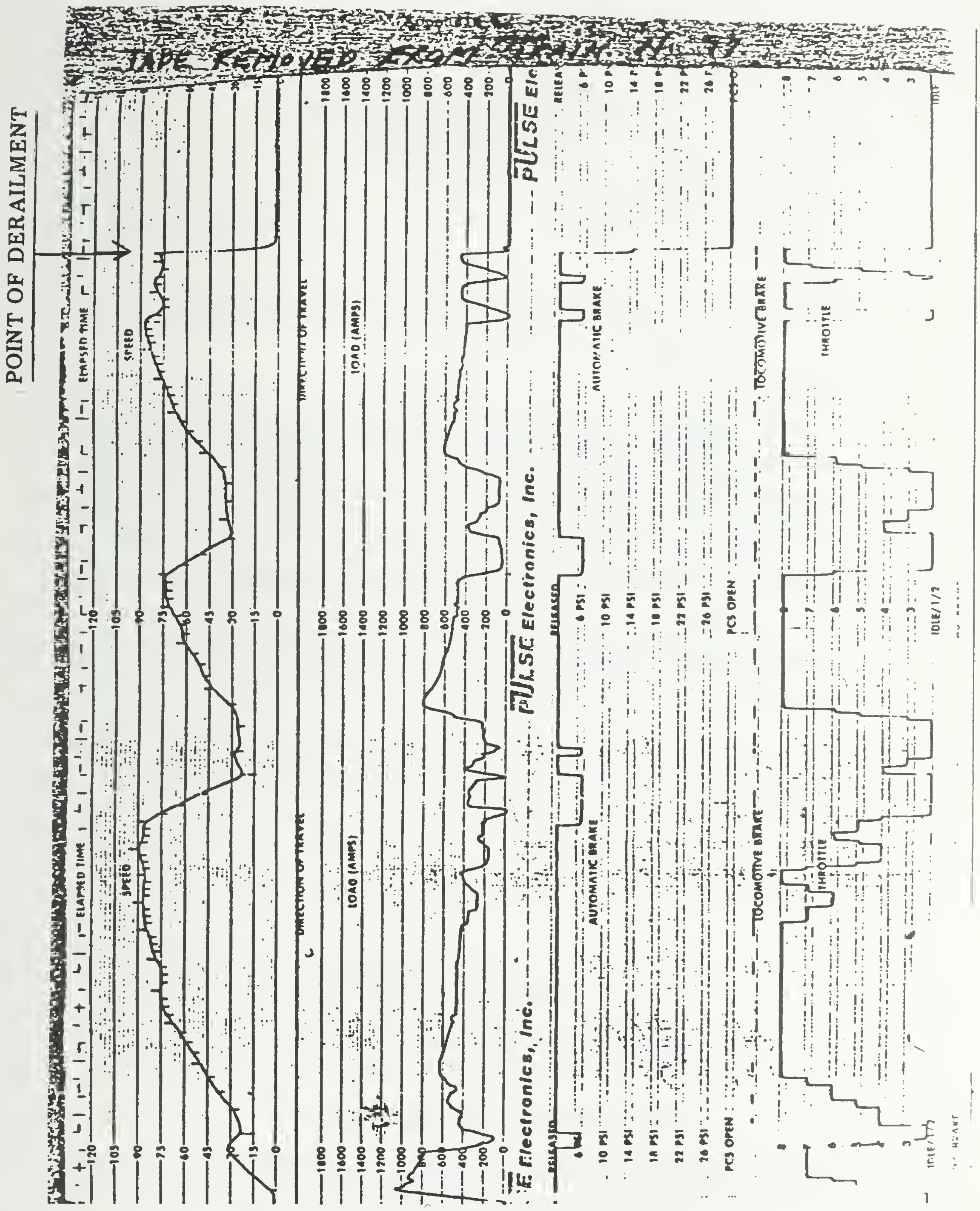
Robert Ronald Chambers, 28, was employed as a fireman by the SCL on November 18, 1972. His last company physical examination was on November 13, 1972, and his last SCL operating rules examination was on November 13, 1980.

Signal Maintainer

Michael P. Williams, 29, was employed by the SCL on October 6, 1969, as an assistant signalman in Jacksonville, Florida. His last company operating rules exam was on April 22, 1980. As a signal department employee, he was not required to take a periodic physical examination.

APPENDIX C

EVENT RECORDER TAPE FROM TRAIN NO. 97



APPENDIX D

SEABOARD COAST LINE RAILROAD COMPANY
SIGNAL INSTRUCTION LETTER NO. 5

SEABOARD COAST LINE RAILROAD COMPANY

SIGNAL INSTRUCTION LETTER

NO. 5

Issued: November 24, 1970
Jacksonville, Florida
192

SUBJECT: Department of Transportation, Federal Railroad Administration, Bureau of Railroad Safety, Rules, Standards, and Instructions for Railroad Signal Systems.

ALL CONCERNED:

The attached Rules, Standards, and Instructions for Installation, Inspection, Maintenance, and Repair of Automatic Block Signal Systems, Interlocking, Traffic Control Systems, Automatic Train Stop, Train Control and Cab Signal Systems, and other Similar Appliances, Methods, and Systems, published November, 1969, by the Department of Transportation, Federal Railroad Administration, covering the Federal Regulations relating to railroad signal systems are hereby made a part of Signal Instruction Letter No. 5. They have the status of Federal Law and apply to all railroads in the United States.

These Rules, Standards, and Instructions must be studied, understood, and complied with by all Signal employees. They are of equal importance with the Operating Rules and Safety Rules.

Be governed accordingly.

J. R. DePriest
Superintendent Communications and Signals

* * *

§ 236.4 Interference with normal functioning of device.

The normal functioning of any device shall not be interfered with in testing or otherwise without first taking measures for insuring safety of train operation which depends on normal functioning of such device.

APPENDIX E

SEABOARD COAST LINE RAILROAD COMPANY
SIGNAL INSTRUCTION LETTER NO. 6

SEABOARD COAST LINE RAILROAD COMPANY

SIGNAL INSTRUCTION LETTER

NO. 6

Issued: February 1, 1971
Jacksonville, Florida

192

SUBJECT: Signal Tests.

ALL CONCERNED:

Operating Rule 1181 states, "They shall be responsible for the proper maintenance and operation of all equipment in their charge and shall do no work thereon that will delay or interfere with the safe passage of trains. Their work must be programmed so that it does not cause delay to trains. They shall conform to prescribed standards and plans in the execution of work in their charge. They shall not make or permit any changes without authority." Department of Transportation, Federal Railway Administration Rule 236.4, states, "The normal functioning of any device shall not be interfered with in testing or otherwise without first taking measures for insuring safety of train operation which depends on normal functioning of such device." (See Signal Instruction Letter No. 5).

The following instructions are intended to make clear to all Communications and Signals Department employees what must be done immediately following a replacement of a device or a change of a circuit in our signaling systems so as to comply with the above rules.

A. General Instructions.

1. Obtain permission from the Dispatcher to temporarily cause signals protecting the location involved to display "Stop."

2. Take action to assure that protecting signals remain at "Stop" until changes are completed.

3. Do not display signal indication except "Stop" to any train until checks outlined below are made to your satisfaction.

B. Circuit Changes.

1. All circuit changes must be made from authorized marked plans or under the direct supervision of a Supervisory Officer.

2. A physical breakdown check must be made of the wiring in the circuit(s) involved to see that the wiring is in accord with the circuit plans.

3. A final operating check must be made to determine that the apparatus or system operates as intended, and meets the requirements of Signal Instruction Letter No. 5 for the type system or apparatus involved.

   In addition, when signals are involved, all aspects must be checked to determine that they are in accordance with the plans and operate as intended.

4. Where highway crossing signals are involved, operating checks must be made to determine that the signals operate properly on approach and passage of trains. Lights, bell and gates must function as intended.

C. Apparatus Replacement.

1. Plug Coupled Apparatus:

   Determine that the device functions properly. For example, for a neutral relay, see that it picks up and drops out properly; for a polar relay, see that the neutral AND polar contacts function properly in all positions; for a rectifier, see that it charges properly; for a code unit, see that it responds to coding properly; etc.

2. Non-Plug Coupled Apparatus:

   Make all checks prescribed in C-1 above and, in addition, determine that all circuits wired through the device being changed are functioning properly according to the plans and as intended and that all nomenclature tagging on the devices is in accordance with plans.

Be governed accordingly.

J. R. DePriest

Superintendent Communications and Signals

APPENDIX F

SEABOARD COAST LINE RAILROAD COMPANY SIGNAL INSTRUCTION LETTER NO. 11

Seaboard Coast Line Railroad Company
Signal Instruction Letter
No. 11

Issued June 1, 1981
Jacksonville, Florida

Subject: Interference with normal functioning of any signal device.

Maintenance and repair work, which may interfere with safe movement of trains must not be started until train movements have been fully protected. Relays must not be tilted or turned over to close contacts. Contacts of relays or other controlling devices shall not be bridged without first taking proper measures to insure safe operation of trains. Under no circumstances will jumpers be left without authority of Supervisor C&S.

R. D. Liggett
Chief Communications and Signals Officer

APPENDIX G

SIGNAL AND TRAIN CONTROL INSPECTION REPORT

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION

SIGNAL AND TRAIN CONTROL INSPECTION REPORT

B.R. Hightower

PAGE 1 OF 1 (Receipt acknowledged)

1 INSPECTOR	PAYROLL ID NO	2 RPT NO	3 REGION	4 RAILROAD REPRESENTATIVE (PRINT NAME AND TITLE)
Grady V Hoffman	39931	33	3	B.R. HIGHTOWER, ASST. SUPV. SIGNALS

5 RAILROAD	CODE	6 RAILROAD DIVISION CODE	7 RAILROAD SUBDIVISION	8 REPORT DATE YEAR	MONTH	DAY	9 SYSTEM INSPECTED
SEABOARD COASTLINE RAILROAD	SCL	TAMPA		81	03	25	TCS

10 INSPECTION LOCATION FROM STATE	CODE	CITY	CODE	11 INSPECTION LOCATION TO CITY	CODE	12. VIOLATION RPT FILED	CODE	13 SOURCE CODE	14 FILE NO
FLORIDA	12	POLK	C105			1. YES (circled) 2. NO	1	2	

15 INSPECTION SUMMARY

A CODE	B UNITS	C CODE	D. UNITS	E CODE	F. UNITS	G CODE	H UNITS	I. CODE	J. UNITS	K. CODE	L. UNITS
SIGNALS		SWITCHES	1	RECORDS		HIGHWAY GRADECROSSING WARNING SYSTEMS		LOCOMOTIVES			

16 UNITS INSPECTED / 17. DEFECTS / 18. RAILROAD FOLLOWUP

16 A. ITEM	B. MILEPOST SIGNAL SWITCH, OR LOCOMOTIVE NUMBER	C. TRACK NUMBER	D. TYPE CODE	17. A. 49 CFR PART	B. RULE	C. SUB-RULE	D. OPERATING SPEED	E. DESCRIPTION	18. A. ACTION	B. DATE
1	MP847.0	M	W	236	004	01	79	INTERFERENCE WITH NORMAL FUNCTIONING OF DEVICE WITHOUT TAKING MEASURES TO INSURE SAFETY OF TRAIN OPERATION.	Corrected	3-27-81

DEPARTMENT OF TRANSPORTATION FEDERAL RAILROAD ADMINISTRATION RECEIVED MAY 11 1981 ATLANTA, GA

FORM FRA-F 6180-6 (8-78)
REPLACES FORM FRA-F 6180-6 (6-78)

*TYPE CODES–S-SIGNAL W-SWITCH L-LOCOMOTIVE R-RECORDS AND TEST O-OTHER

(For additional space use Form FRAF 6180-5A, Continuation Sheet)

RAILROAD COPY

*U.S. GOVERNMENT PRINTING OFFICE : 1981 0-361-828/81